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MCR-76-465

CONTRACT NAS8-31912

FINAL REPORT

October 1976

# Analytical Study of Lightweight Acoustic Shrouds for Shuttle Experiments and Payloads

(NASA-CR-150116) ANALYTICAL STUDY OF  
LIGHTWEIGHT ACOUSTIC SHROUDS FOR SHUTTLE  
EXPERIMENTS AND PAYLOADS Final Report  
(Martin Marietta Corp.)

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**MARTIN MARIETTA**

MCR-76-465  
Contract NAS8-31912

October 1976

FINAL REPORT  
  
ANALYTICAL STUDY  
OF  
LIGHTWEIGHT ACOUSTIC SHROUDS  
FOR  
SHUTTLE EXPERIMENTS AND PAYLOADS

Contract NAS8-31912

Prepared for:  
National Aeronautics and Space Administration  
George C. Marshall Space Flight Center  
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## FOREWORD

This report presents the results of a study performed for the Marshall Space Flight Center under Contract NAS8-31912. This work was a continuation of previous studies which indicated that practical, lightweight, acoustic shrouds could provide noise protection for a high percentage of the total experiment population for Space Shuttle. Specifically, this study was directed towards investigating the effects of a helium filled liner to reduce shroud weight and increase noise reduction.



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## INTRODUCTION

This report presents a description and results of acoustic tests performed on an STS payload shroud simulator to determine the effects of a helium filled liner on the noise reduction characteristics. The basic test program included the following configurations:

1. Bare Shroud (baseline configuration);
2. Shroud with empty liner;
3. Shroud with liner filled with air; and
4. Shroud with liner filled with helium.

The results of this test series indicated negligible effects from the helium and two additional configurations were tested to provide additional information.

1. Liner filled with air; and
2. Liner filled with helium.

The data from these configurations indicated increased noise reduction from the use of helium.

## TEST DESCRIPTION

### Shroud/Test Configurations

Tests were conducted on two shroud configurations. The first configuration consisted of a composite fiberglass shroud and mylar liner restrained by a metal screen and ring frame stiffeners to provide support to the gas bag liner so that the gas layer could be maintained at a relatively uniform thickness of 5 cm (2 inches). A sketch of the shroud configuration is shown in Figure 1. Double walled mylar liners were also installed on the cylinder end caps (not shown in the sketch) to eliminate possible flanking paths. The shroud was approximately 0.9 meters in diameter and 1.8 meters long.

For the second configuration, the mylar liner was removed from the composite shroud and the outer surface was restrained by a wire mesh screen as shown in Figure 2.

The shroud was suspended on nylon rope within the acoustic chamber and exposed to a simulated Shuttle payload bay acoustic environment produced by two Wyle WAS 3000 noise generators coupled to the chamber at top and bottom.

Tests were conducted on the following configurations:

1. Empty shroud (baseline configuration);
2. Shroud with empty liner;
3. Shroud with liner filled with air;

4. Shroud with liner filled with helium;
5. Screen enclosed liner filled with air; and
6. Screen enclosed liner filled with helium.

A small vacuum pump was used to collapse the liner prior to filling with helium. For all configurations in which the liner was filled with either air or helium, only a sufficient gas pressure (nominally  $3448 \text{ N/m}^2$ , or 0.5 psi) was used to expand the enclosed liner to the 5 cm wall spacing.

The weights of the shroud configurations tested are given in Table 1.

TABLE 1. SHROUD WEIGHTS

Configuration	Total Weight Including End Caps Kg (lbs)	Effective Surface Weight $\text{Kg/m}^2$ (lbs/sq ft)
Composite Foam Shroud	42.2 kg (93.0 lb)	$4.64 \text{ kg/m}^2$ (0.95 lb/ft <sup>2</sup> )
Composite Foam Shroud with Mylar Liner	45.2 kg (99.75 lb)	$5.32 \text{ kg/m}^2$ (1.09 lb/ft <sup>2</sup> )
Screen Enclosed Liner Only	6.1 kg (13.5 lb)	$0.93 \text{ kg/m}^2$ (0.19 lb/ft <sup>2</sup> )

The effective surface weights indicated in Table 1 are based on weights and surface areas relating only to the cylindrical portions of the shrouds. The composite foam/mylar liner shroud included one layer of protective mylar between the liner and screen surface. The wire screen/mylar liner shroud included two layers of protective mylar, one on each side of the liner.



### Instrumentation and Data Reduction

Each test configuration was instrumented with six external and six internal microphones at locations shown in Figure 3. An interior view of the liner showing internal microphone locations is shown in Figure 4. Control of the external acoustic spectrum was accomplished by electronically averaging the output signals of the six external microphones utilizing a General Radio equalizer/analyzer system.

Similarly, the average internal acoustic spectrum was obtained for the six internal microphones. In addition to the average external and internal spectra, one-third-octave band analyses were performed for each of the individual microphones for each test configuration. These data are presented in the appendix to this report.

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## DATA ANALYSIS

### External Acoustic Levels

The external acoustic environment was controlled to a spectrum approximating the Shuttle payload bay environment by electronically averaging the output signals of the six external microphones. A typical plot of the levels at individual microphone locations and of the control average showing the variations in one-third-octave bands is shown in Figure 5. A comparison of electronic averages of the external level for all four tests which used the composite shroud is presented in Figure 6. These data indicate that control of the external environment was very repeatable for the different test configurations utilizing the composite shroud.

### Internal Acoustic Levels

The average internal levels from the four tests of the composite shroud configurations are shown in Figure 7. Internal levels from the two screen enclosed liner tests are presented in Figure 8 and compared to the measured levels obtained from the shroud/liner filled with helium.

### Noise Reduction

Noise reduction plots for the six test configurations are shown in Figures 9 through 14. In each case the noise reduction values were obtained from the difference between the average external and internal one-third-octave band levels.

A comparison of the noise reduction plots for the four tests which utilized the composite shroud is shown in Figure 15. The noise reductions obtained from the screen enclosed liner filled with air and helium are shown in Figure 16.

In addition to the individual noise reduction data presented in the preceding figures, a direct comparison of the effects of the air and helium is shown in Figure 17. The plots in Figure 17 represent the difference in noise reduction for helium versus air, for the liner in the composite shroud and in the wire screen shroud.

Figure 18 shows the noise reduction plots for the six tests performed in this study and the amount of noise reduction provided by each configuration.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

1. A comparison of helium versus air in the screen enclosed liner indicated that the helium provided an increase in noise reduction of approximately 3 dB in one-third-octave bands above 800 Hz. There was no significant change in noise reduction below 800 Hz.
2. The liner installed in the composite shroud produced an increase of 8 to 10 dB in noise reduction at frequencies above 400 Hz. However, at frequencies above the second acoustic mode of the cylinder, there was no significant difference in the noise reduction achieved with the liner empty, filled with air, or filled with helium.
3. At the first and second acoustic modes of the cylinder (approximately 100 and 200 Hz, respectively), the increased absorption provided by the gas filled liner produced an 8 to 10 dB improvement in noise reduction compared to the empty composite shroud.
4. The results of this study indicate that the use of helium in Shuttle payload shrouds would not provide a significant improvement in noise reduction compared to more conventional configurations, at least for the thickness (5 cm) of gas layer investigated. Furthermore, we believe that the problems in design and fabrication associated with containing the helium would significantly increase shroud costs compared to conventional configurations.

### Recommendations

The results of this and previous studies indicate that light-weight shrouds can be developed which can reduce the payload bay acoustic environment to levels which will allow the use of components previously qualified and flown on other boosters. The cost savings associated with elimination of the requalification program and test and flight failures could be significant.

It is recommended that a full-scale prototype shroud be developed to determine the noise reduction achievable and the potential cost savings estimated from previous analyses performed under contract NAS8-31535. In addition, analyses should be conducted to assess the thermal control impact of acoustic shrouds during the various phases of the Shuttle missions. Shroud deployment design concepts should also be investigated.

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## REFERENCES

1. W. P. Rader, et al, Analytical Trade Study of the STS Payload Environment, MCR-76-166, Martin Marietta Corporation, March 1976.



## ABBREVIATIONS AND ACRONYMS

cm	Centimeter
dB	Decibel
ft	Feet
Hz	Hertz
in.	Inch
kg	Kilogram
lb	Pound
m	Meter
MMC	Martin Marietta Corporation
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
N	Newton
psi	Pounds per square inch
SPL	Sound pressure level in dB re $20\mu\text{N}/\text{m}^2$
STS	Space Transportation System

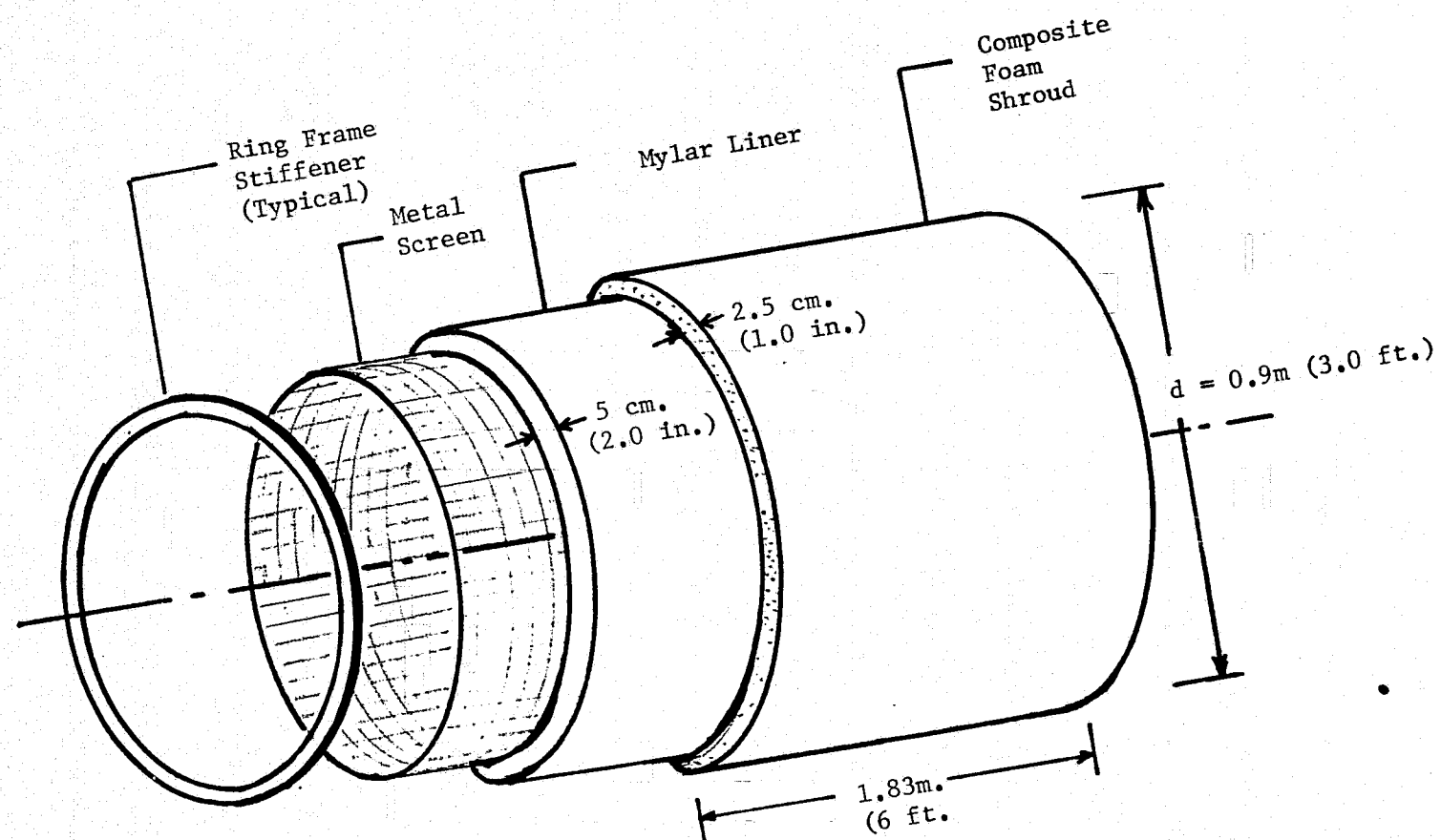


Figure 1. Shroud Configuration.

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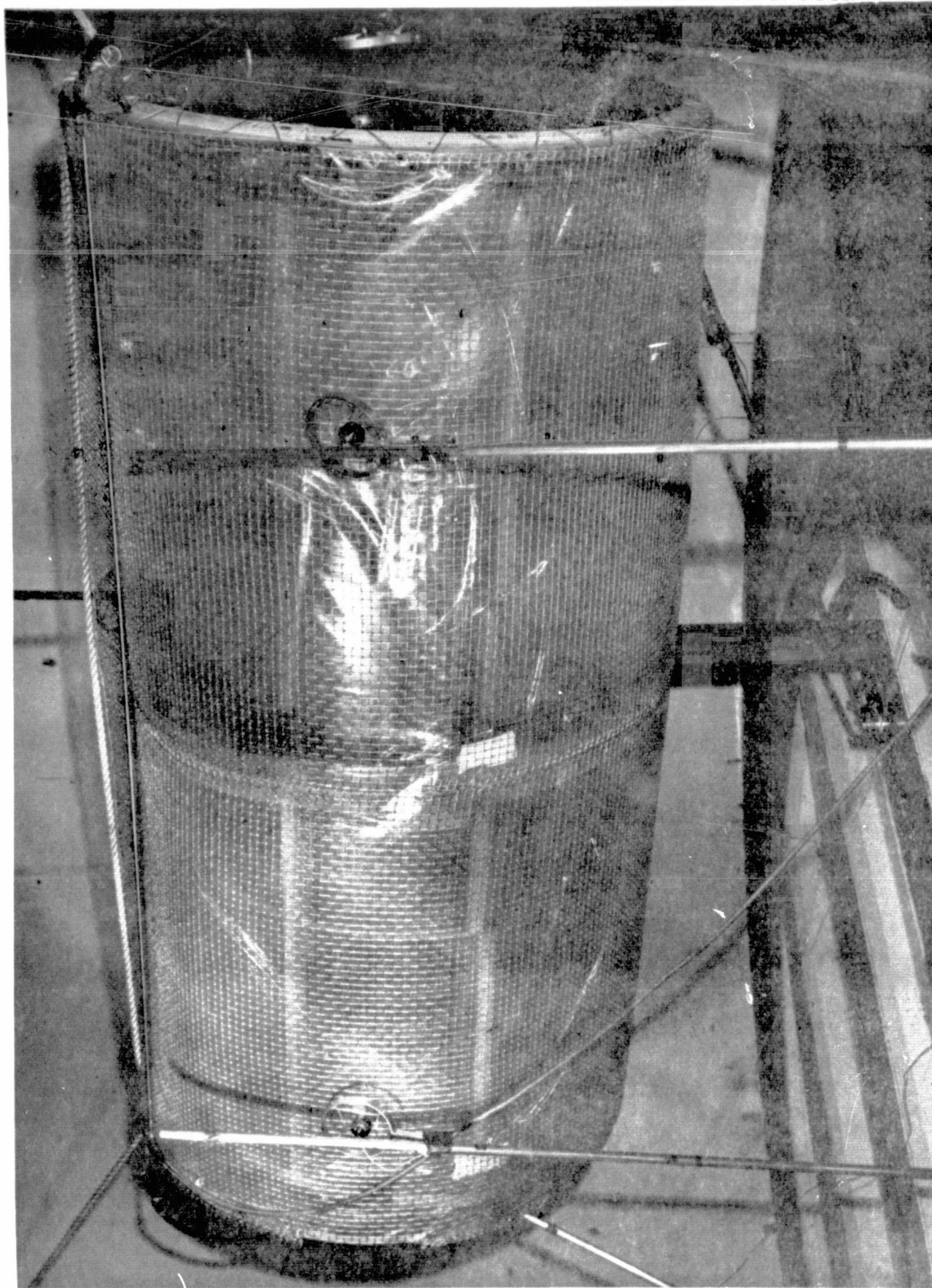


Figure 2. Mylar Liner Suspended in Acoustic Chamber.

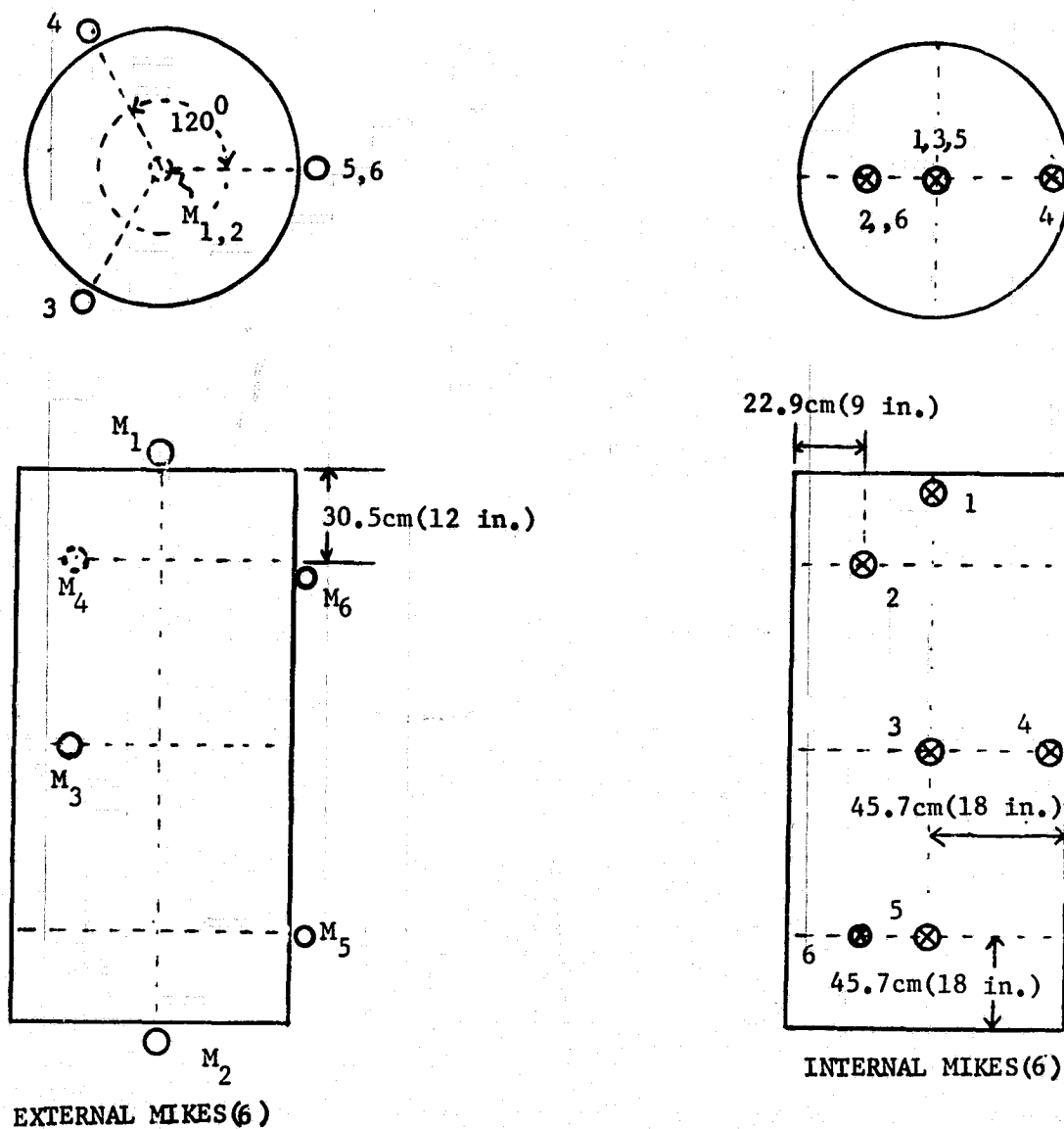


Figure 3. Microphone Locations.

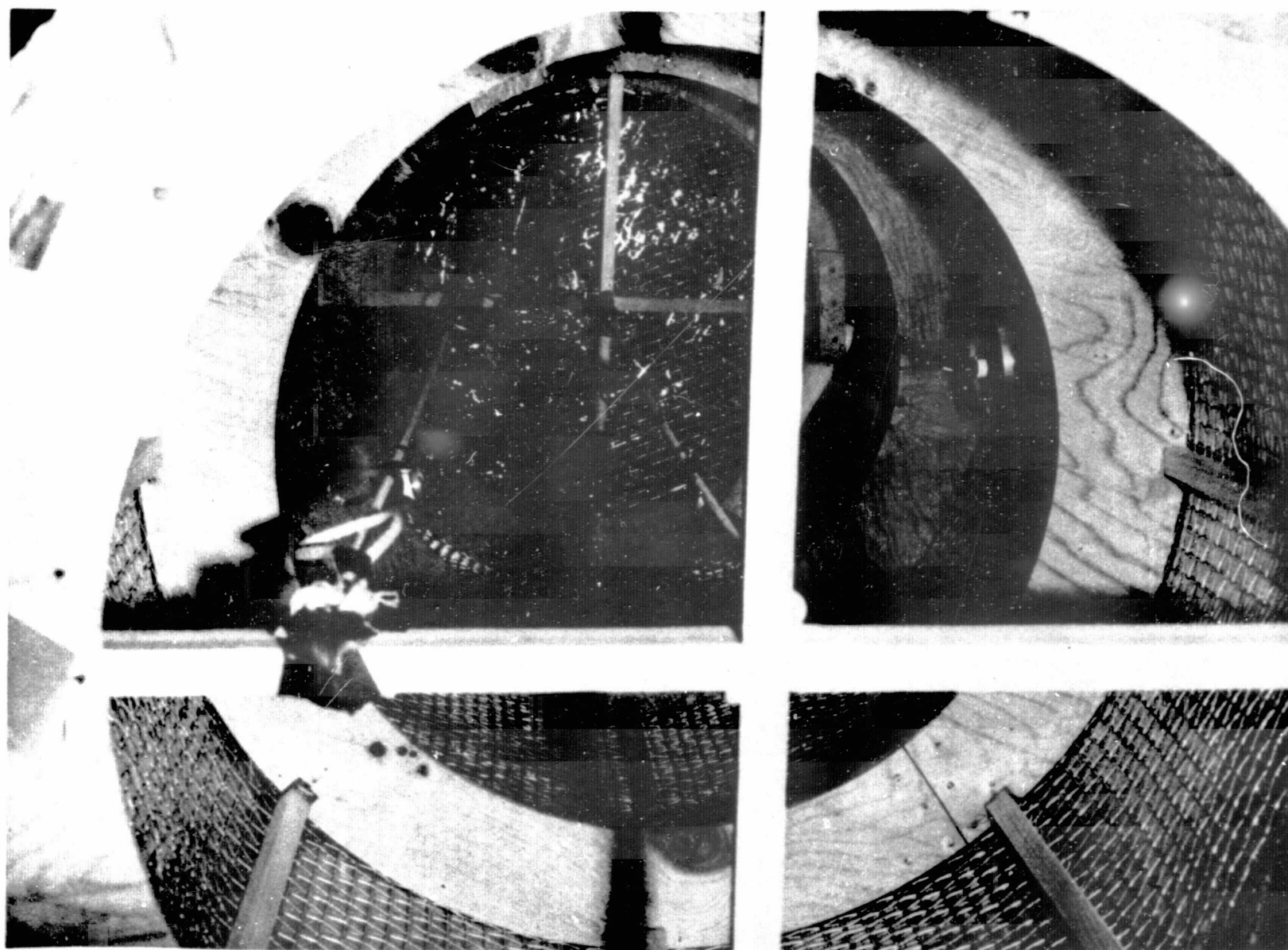


Figure 4. Interior View of Liner Showing Internal Microphones.



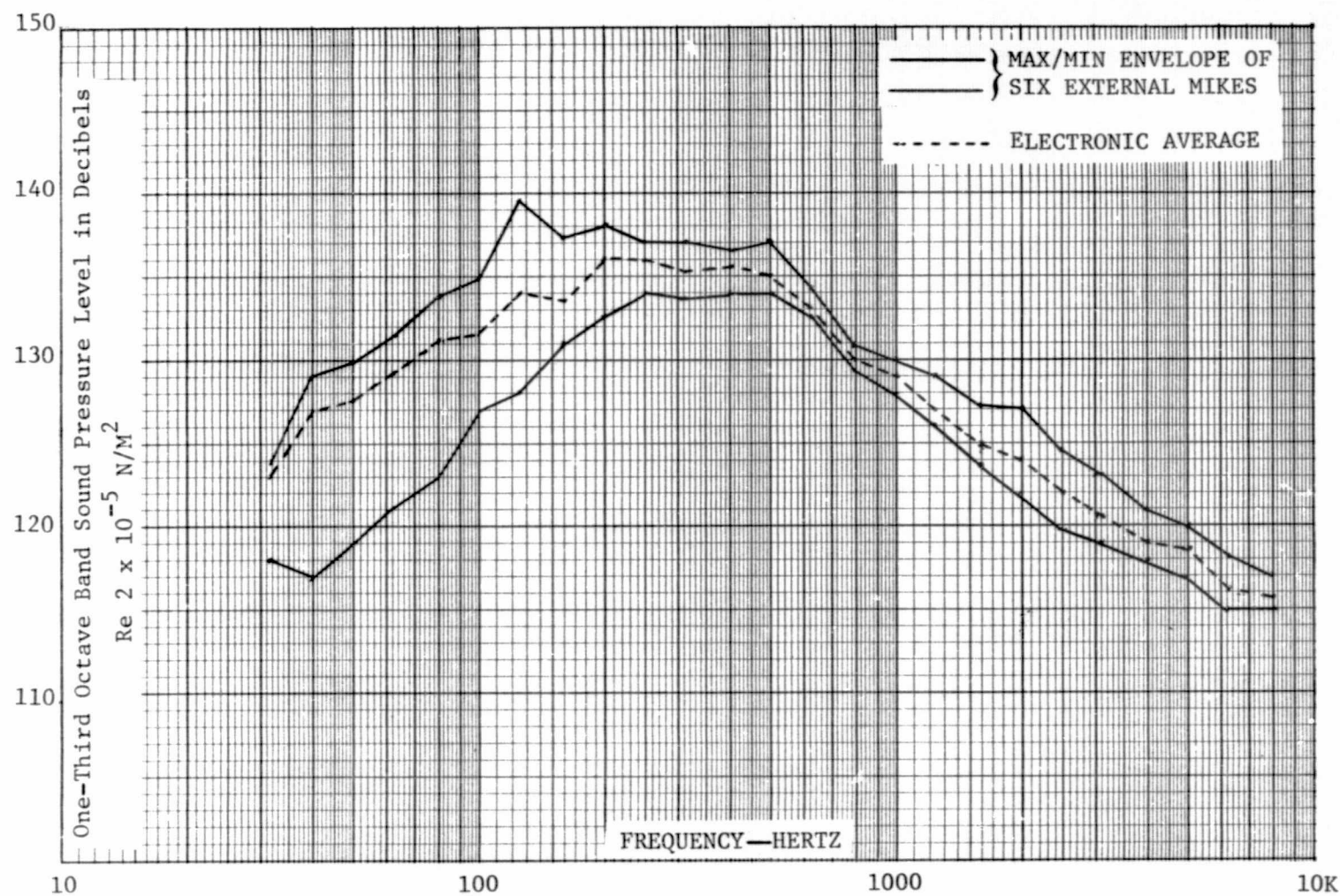


Figure 5. Comparison of External SPL's and Control Average During Shroud/Liner-Air Acoustic Test.



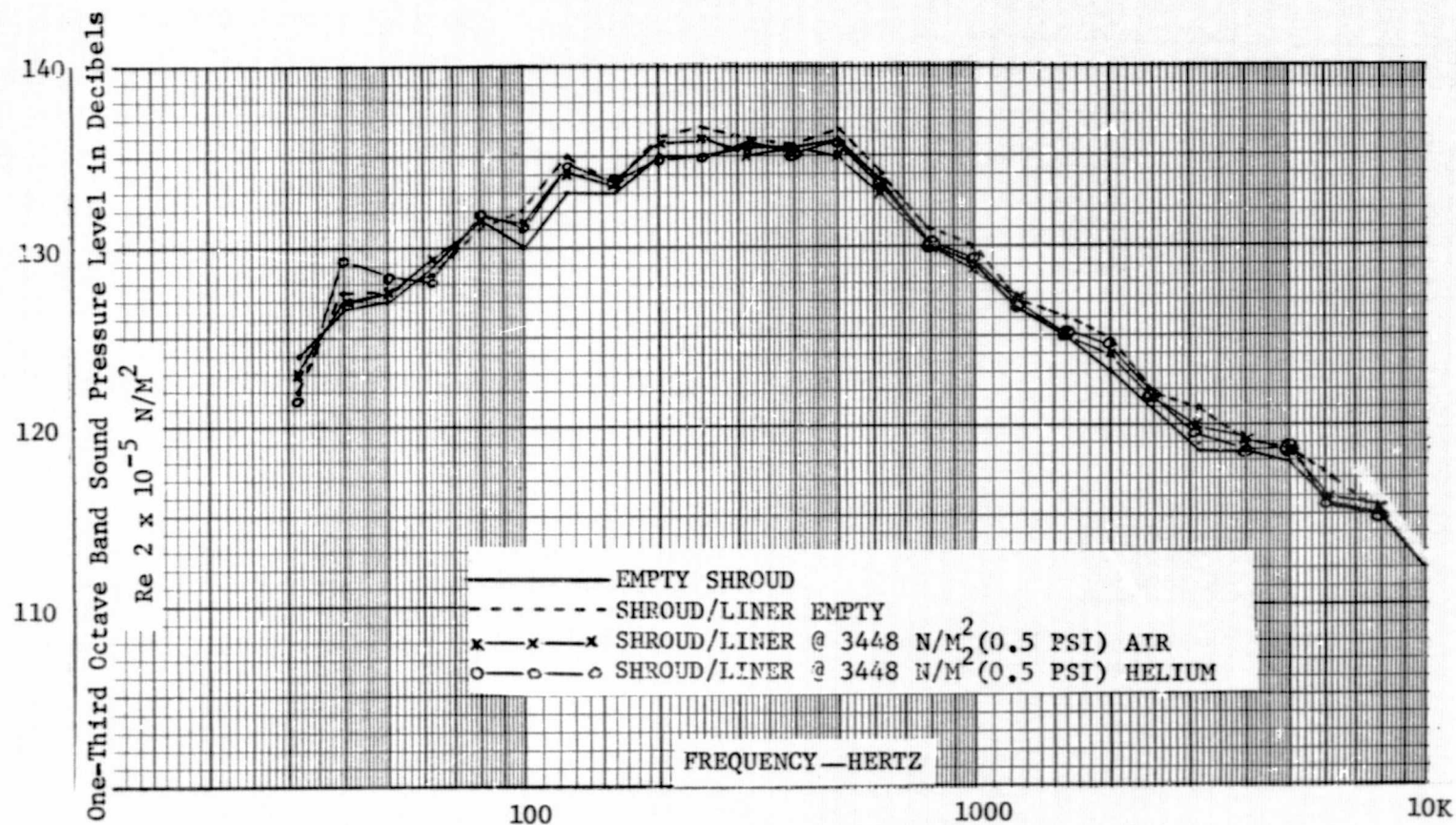


Figure 6. Comparison of Average External Sound Pressure Levels Applicable to Shroud/Liner Tests.

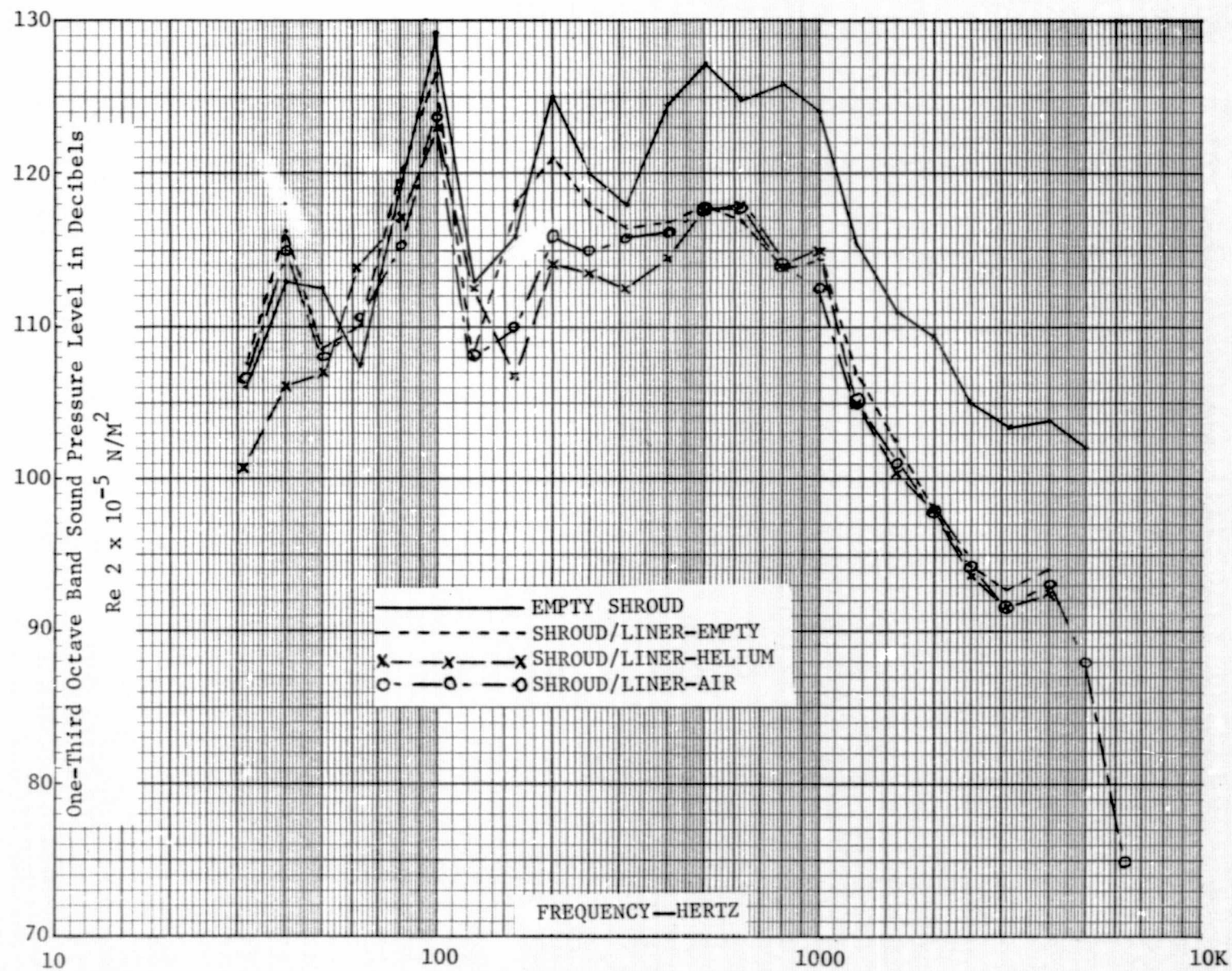


Figure 7. Comparison of Average Internal Sound Pressure Levels Applicable to the Four Shroud/Liner Tests.



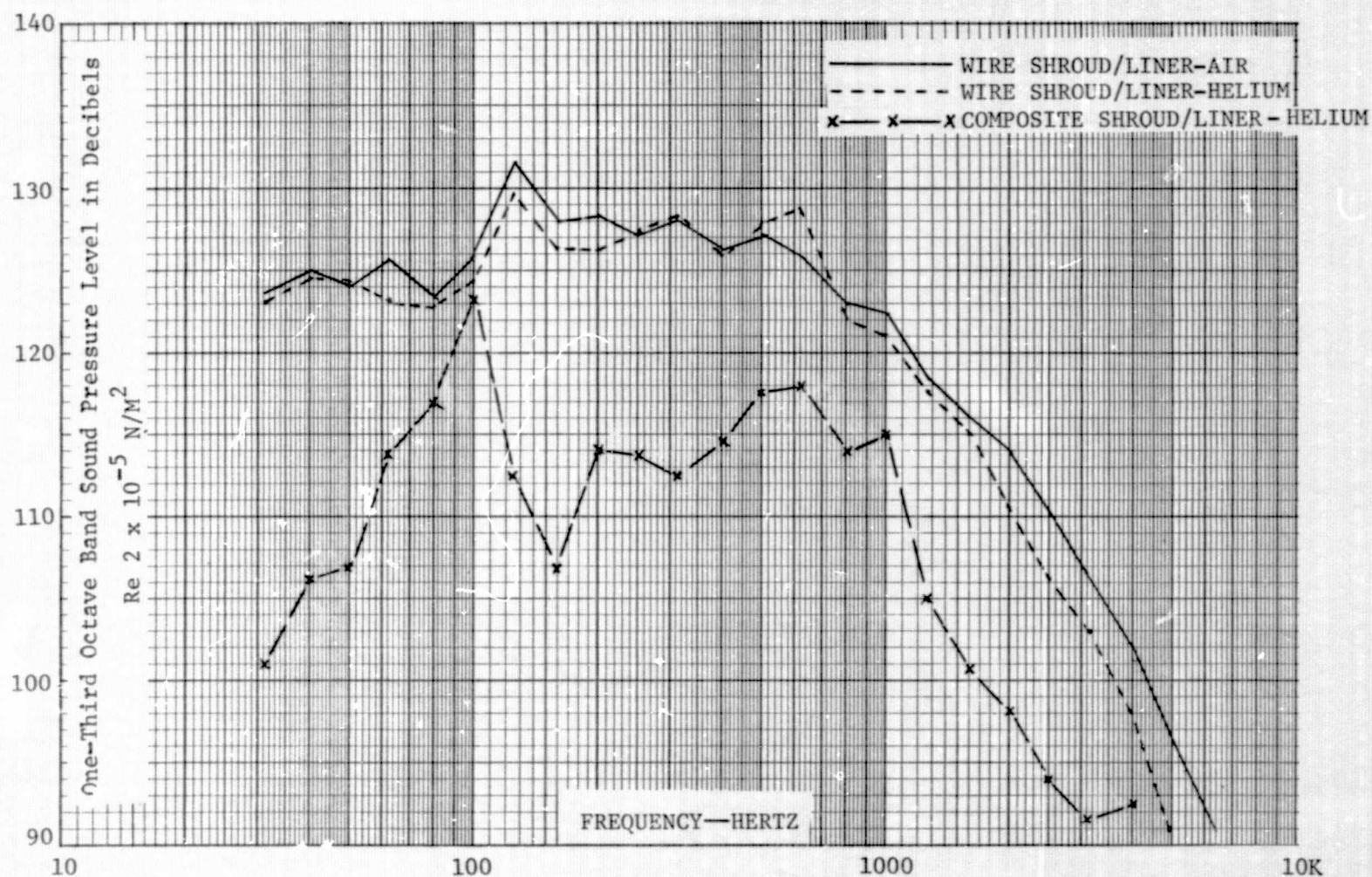


Figure 8. Comparison of Average Internal Sound Pressure Levels for Wire Shroud/Liner and Composite Shroud/Liner.

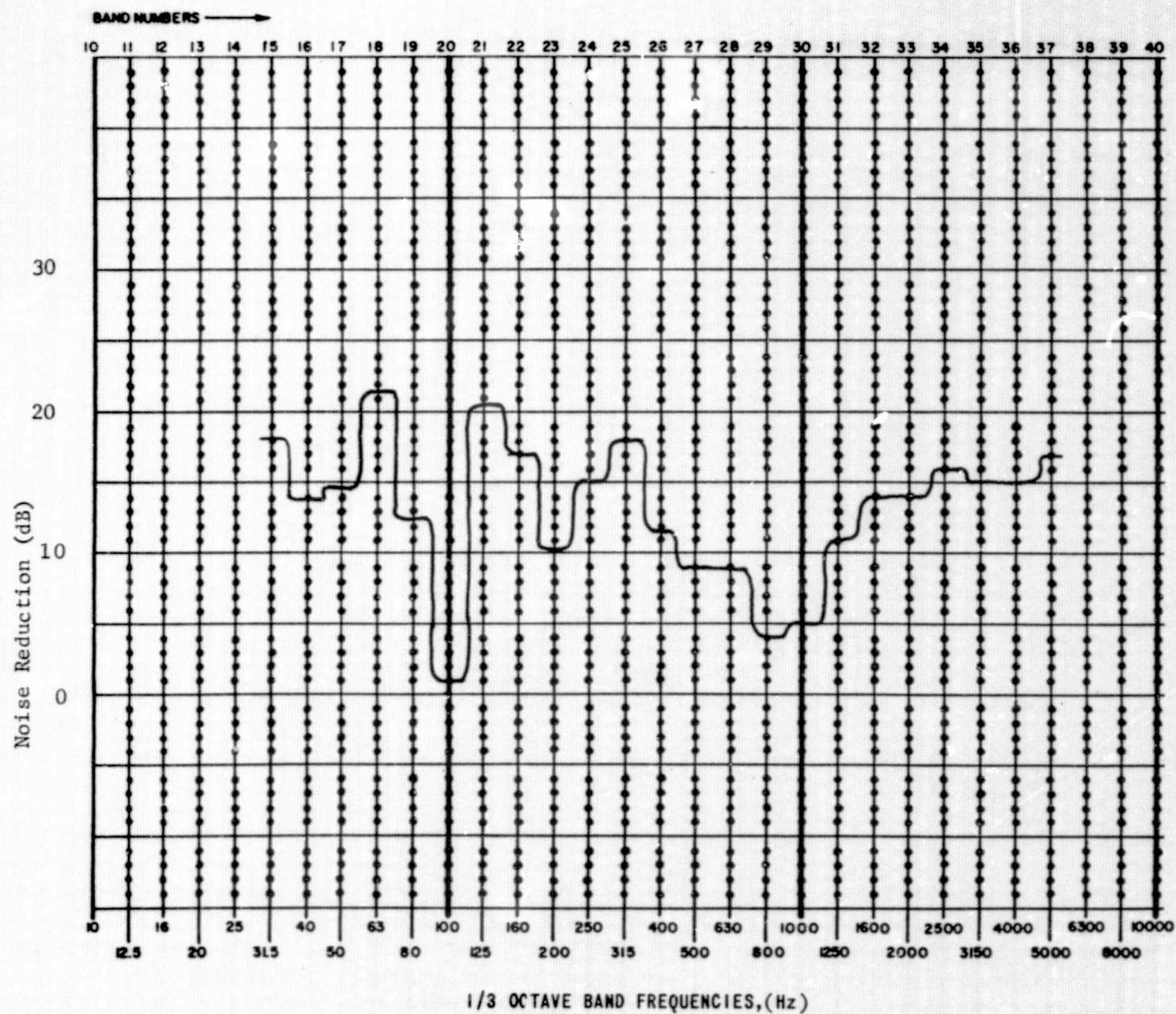


Figure 9. Noise Reduction From Composite Shroud (Baseline Configuration).



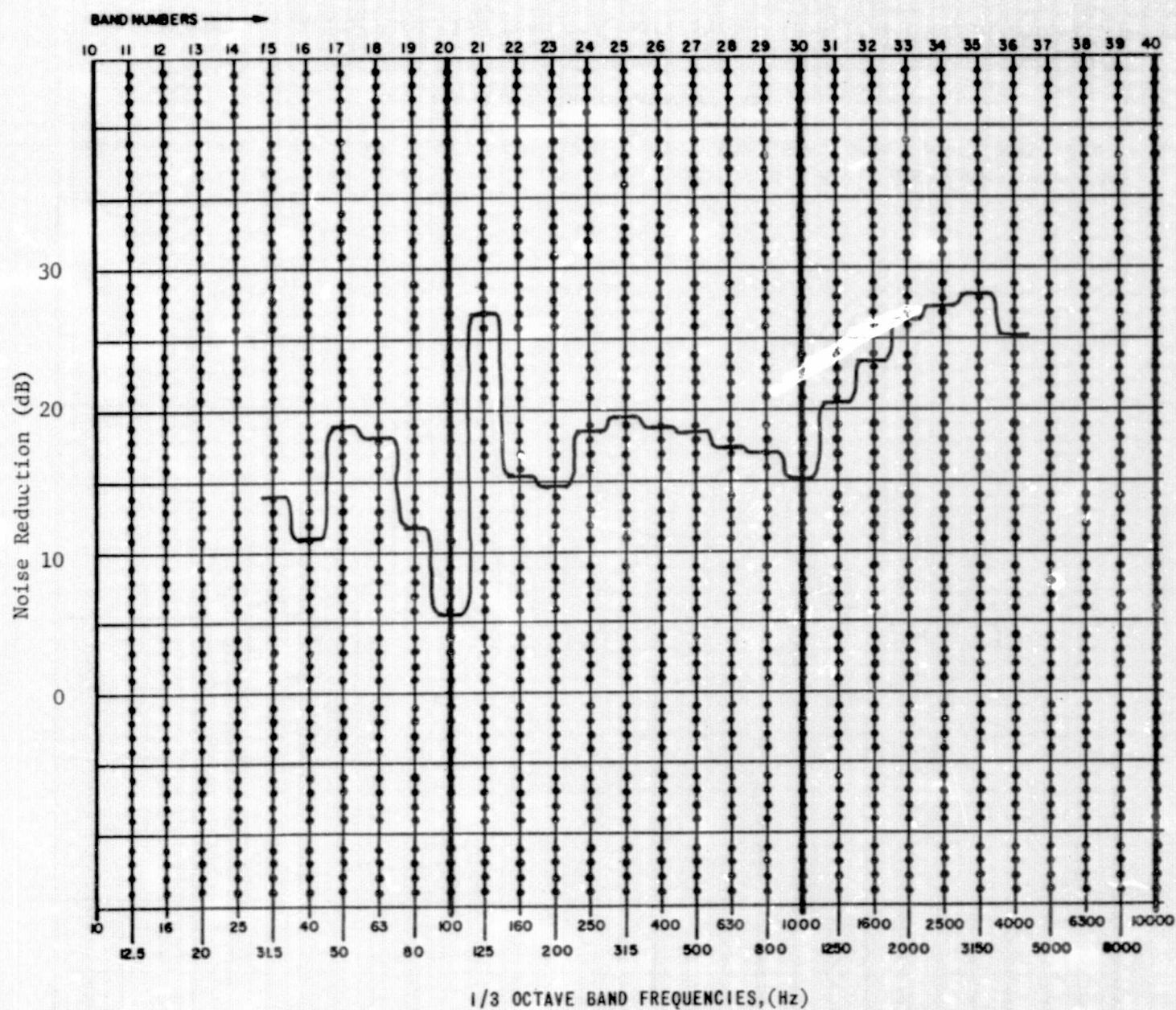


Figure 10. Noise Reduction From Composite Shroud With Empty Liner.

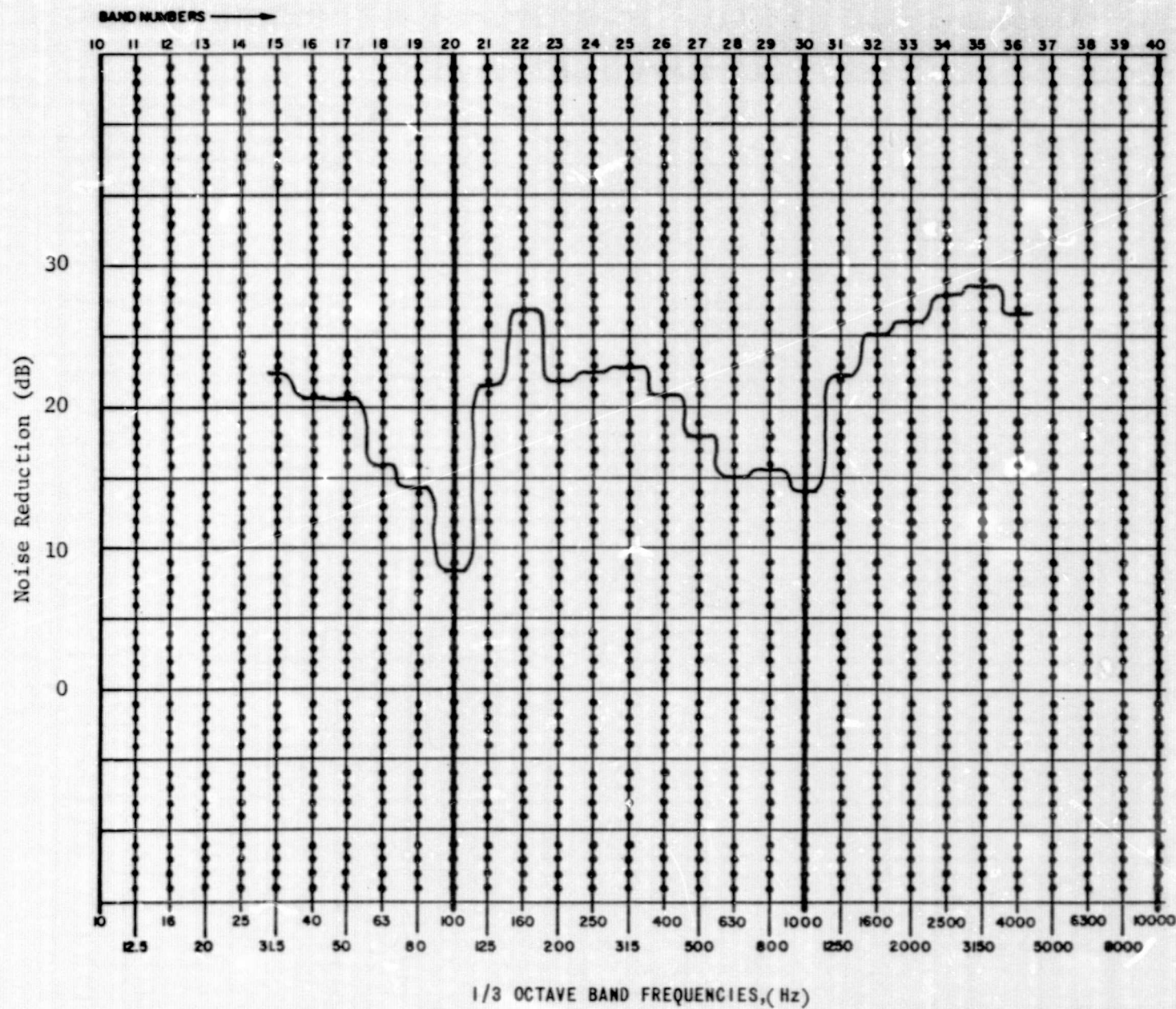


Figure 11. Noise Reduction From Composite Shroud With Liner Filled With Air.



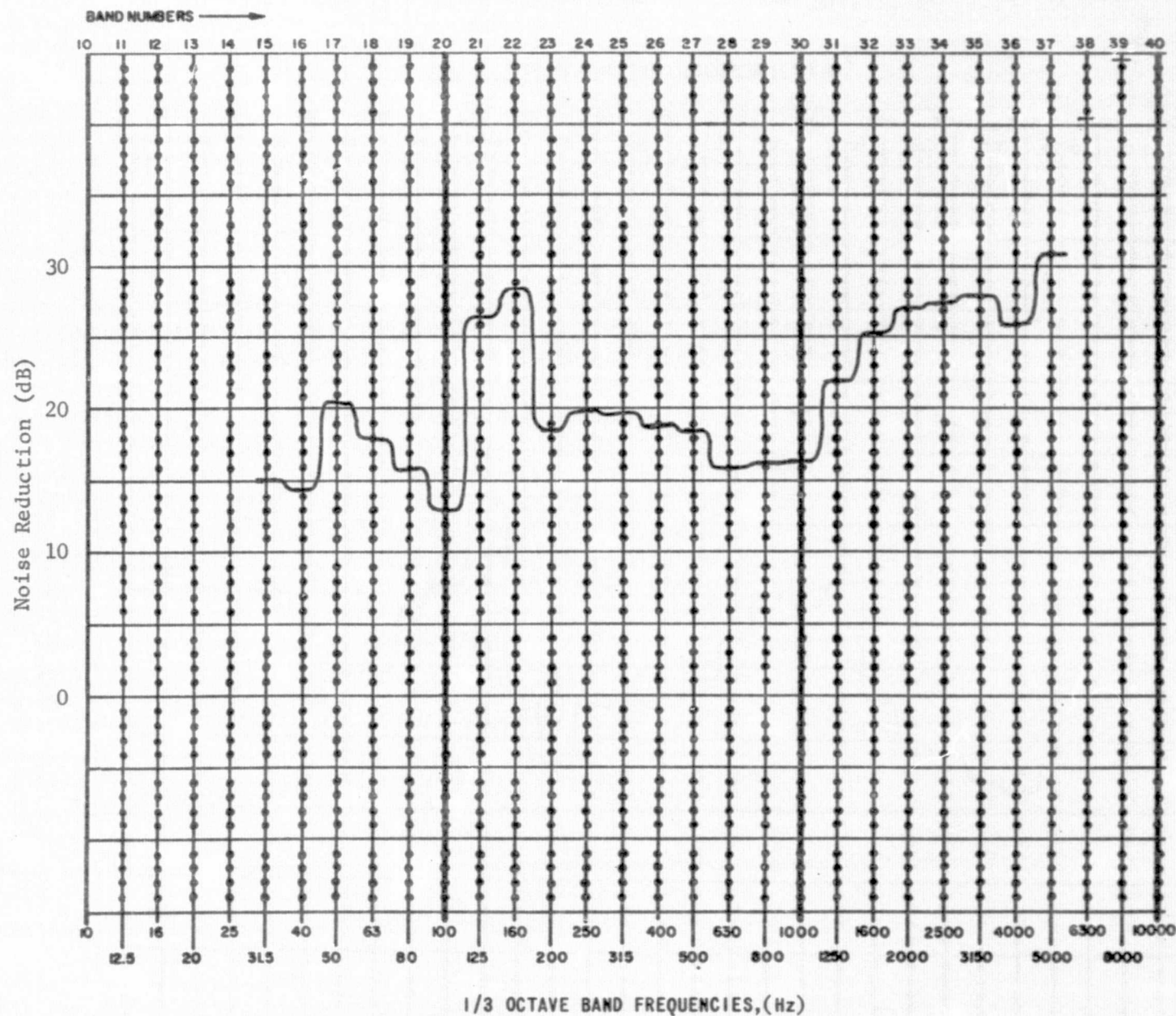


Figure 12. Noise Reduction From Composite Shroud With Liner Filled With Helium.

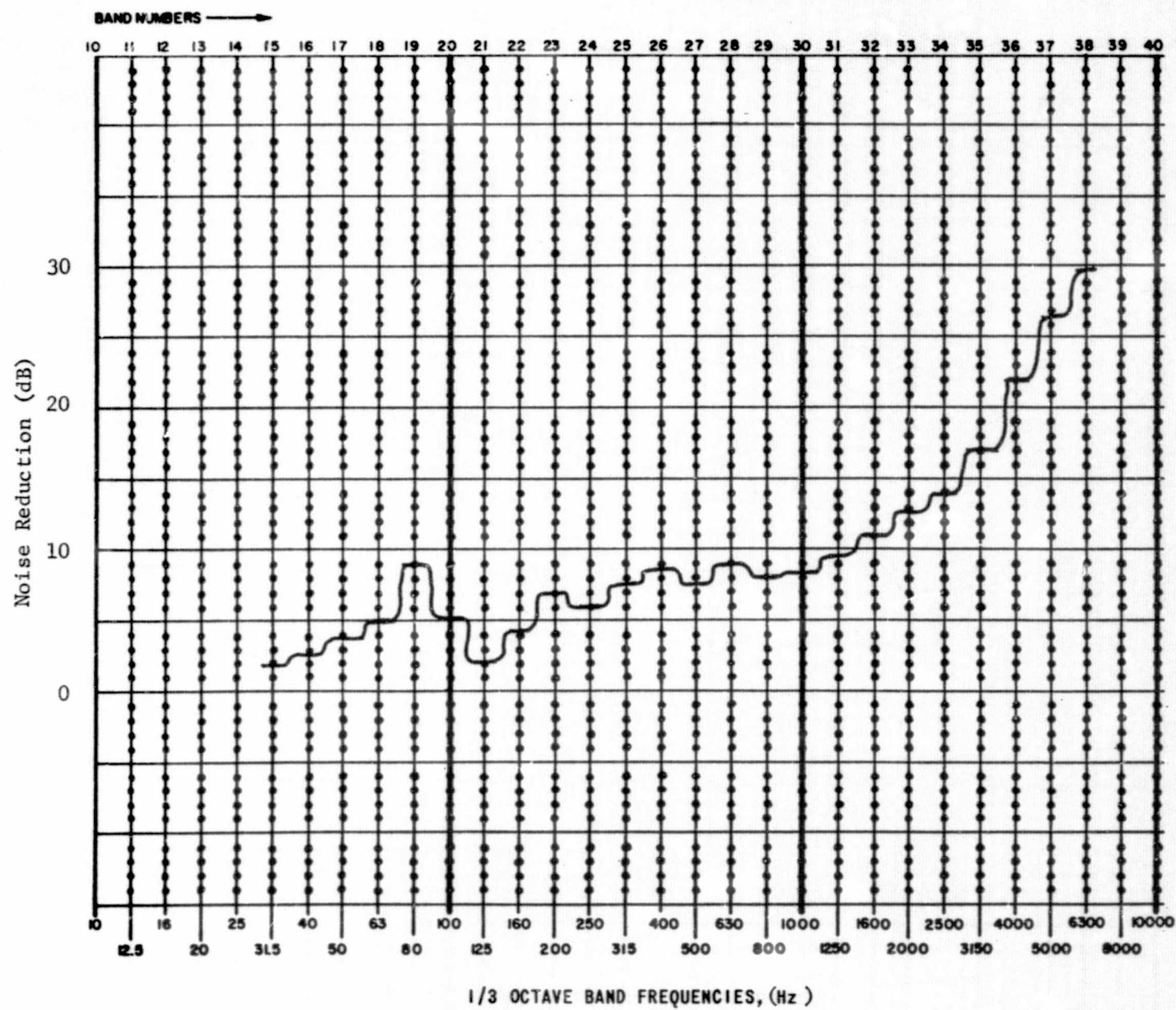


Figure 13. Noise Reduction From Screen Enclosed Liner Filled With Air.

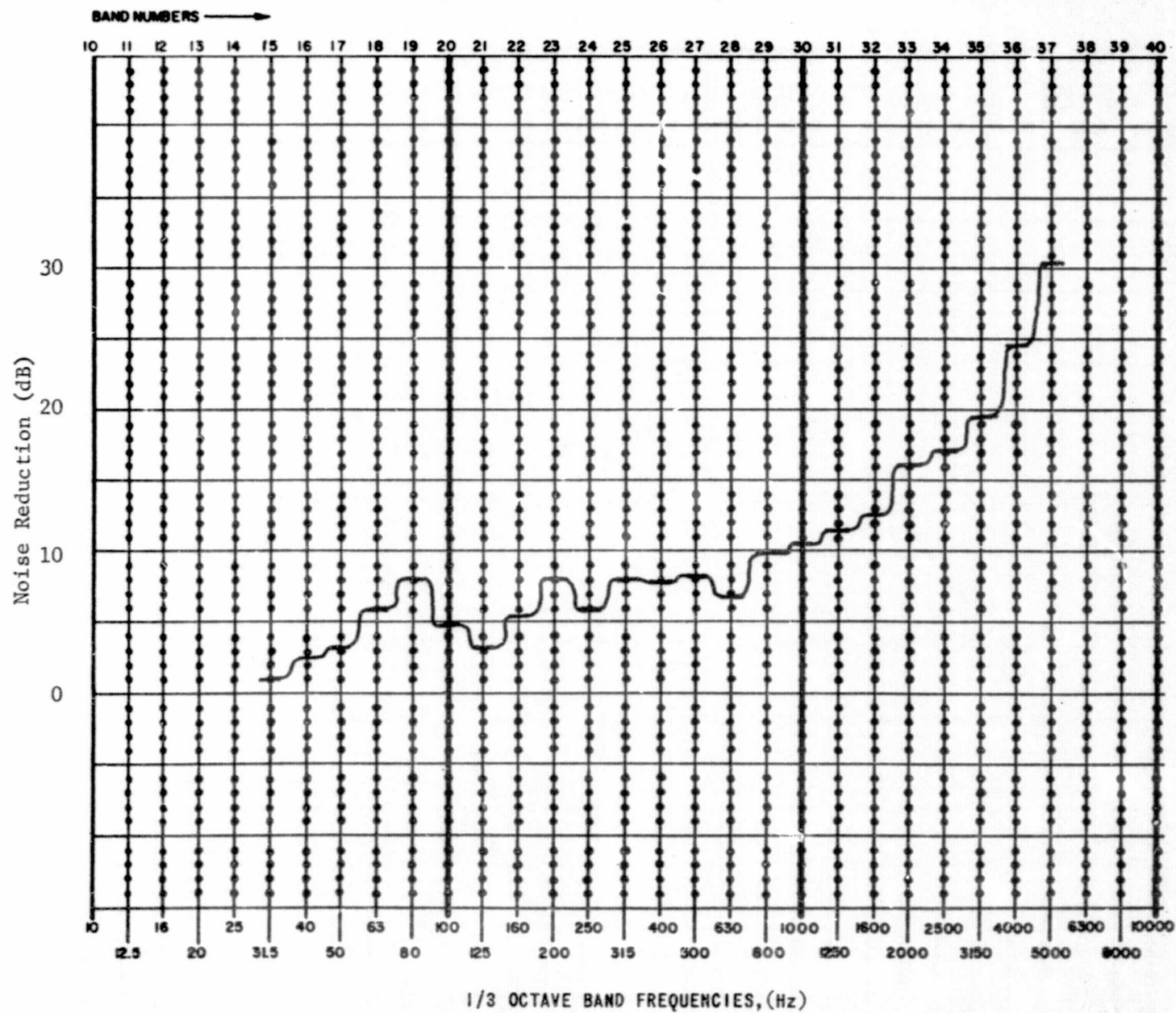


Figure 14. Noise Reduction From Screen Enclosed Liner Filled With Helium.



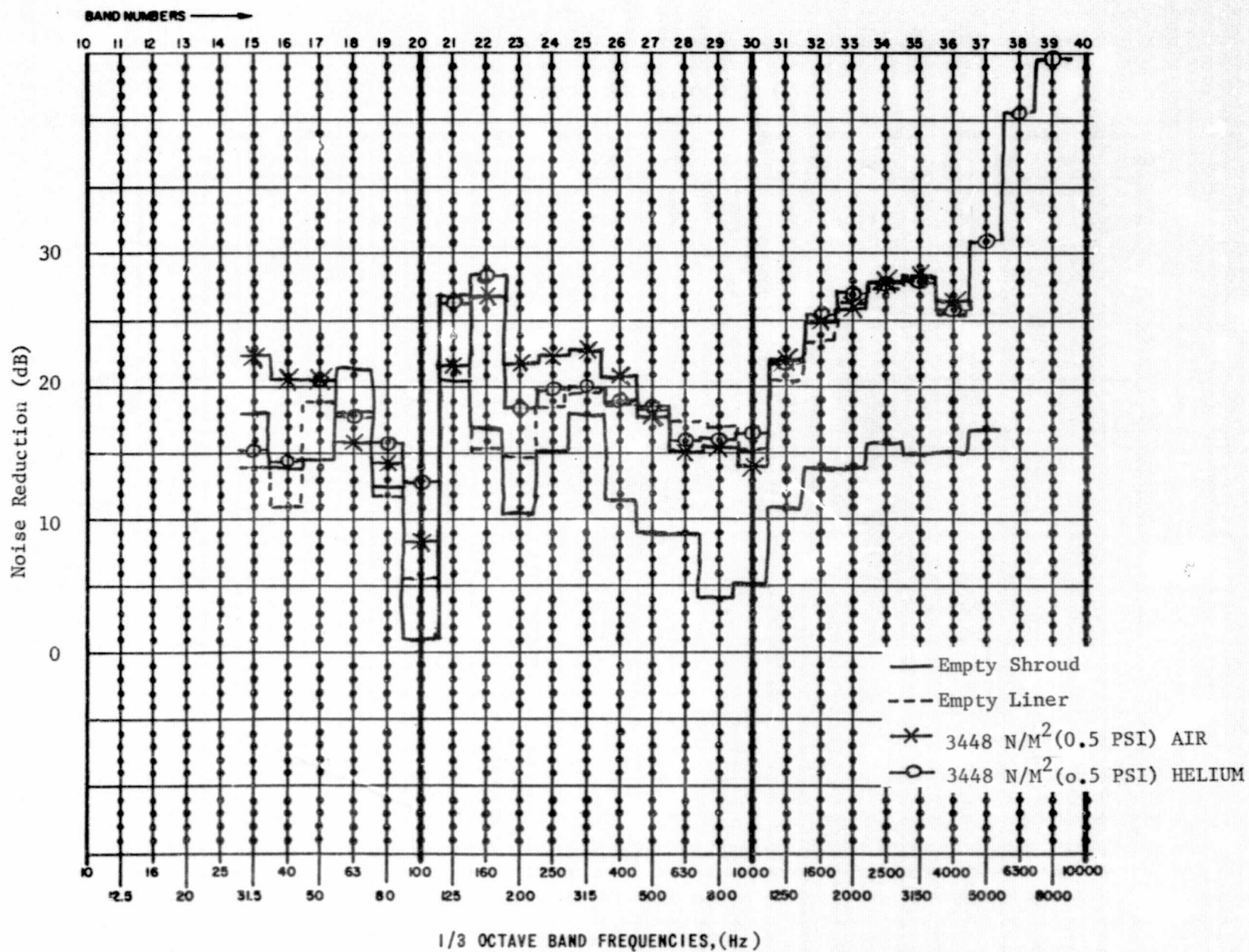


Figure 15. Comparison of Noise Reduction Obtained For Four Different Shroud Configurations.

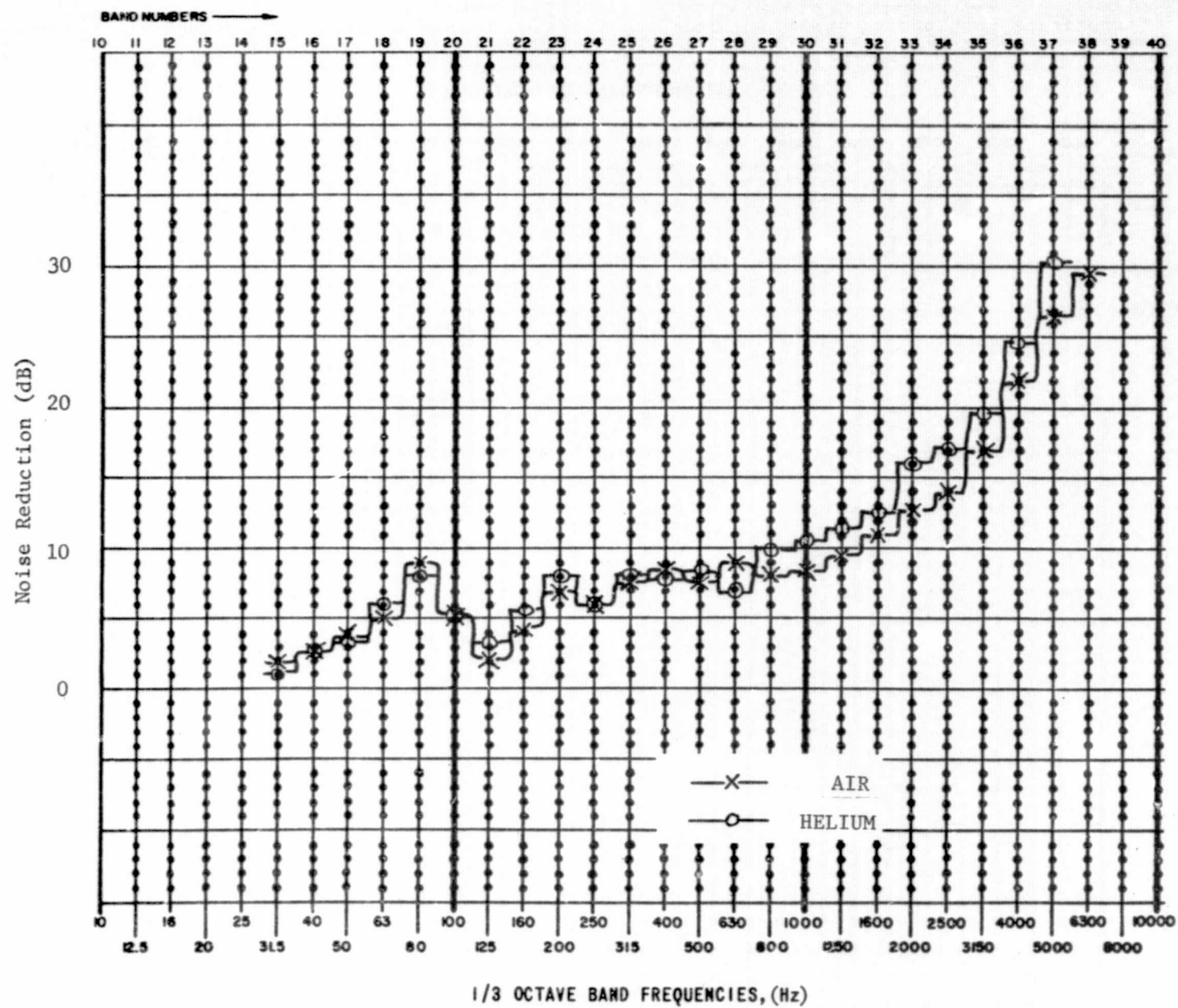


Figure 16. Comparison of Noise Reduction From Air and Helium Filled Liner.

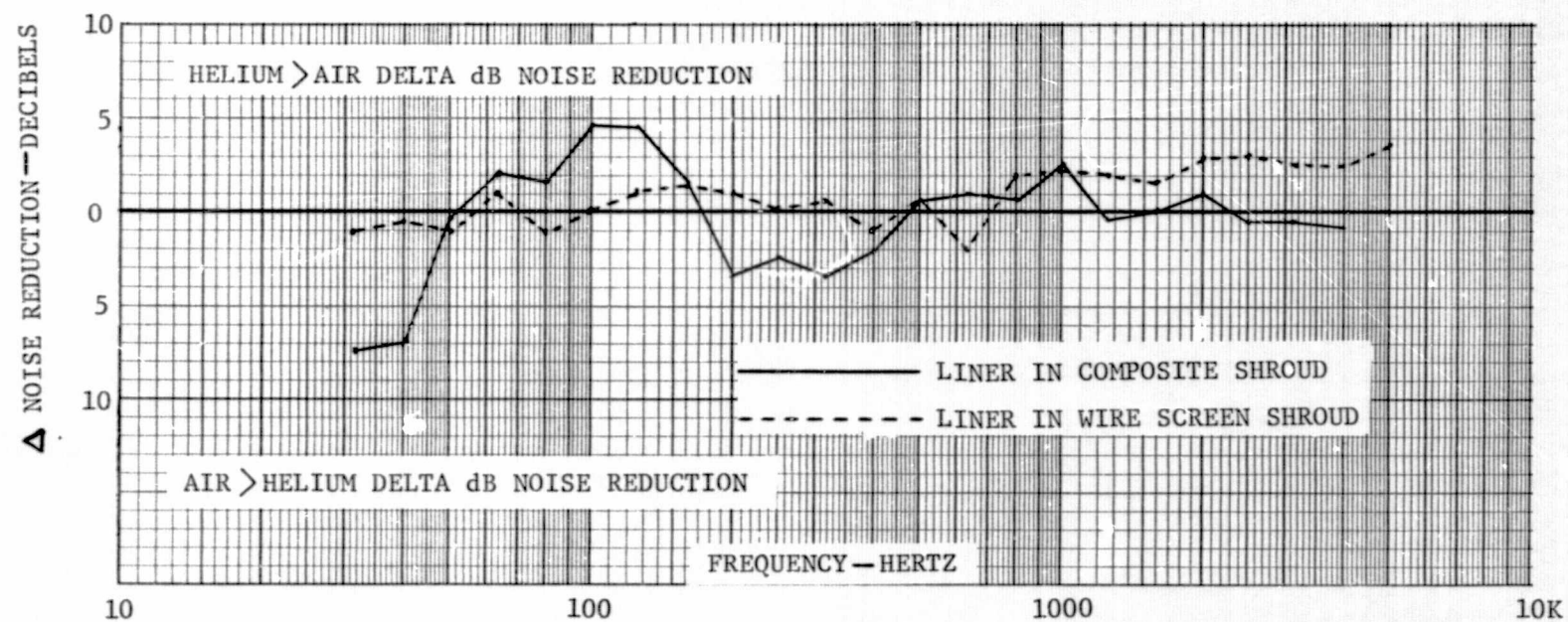


Figure 17. Comparison of Helium Versus Air Delta dB Noise Reduction.



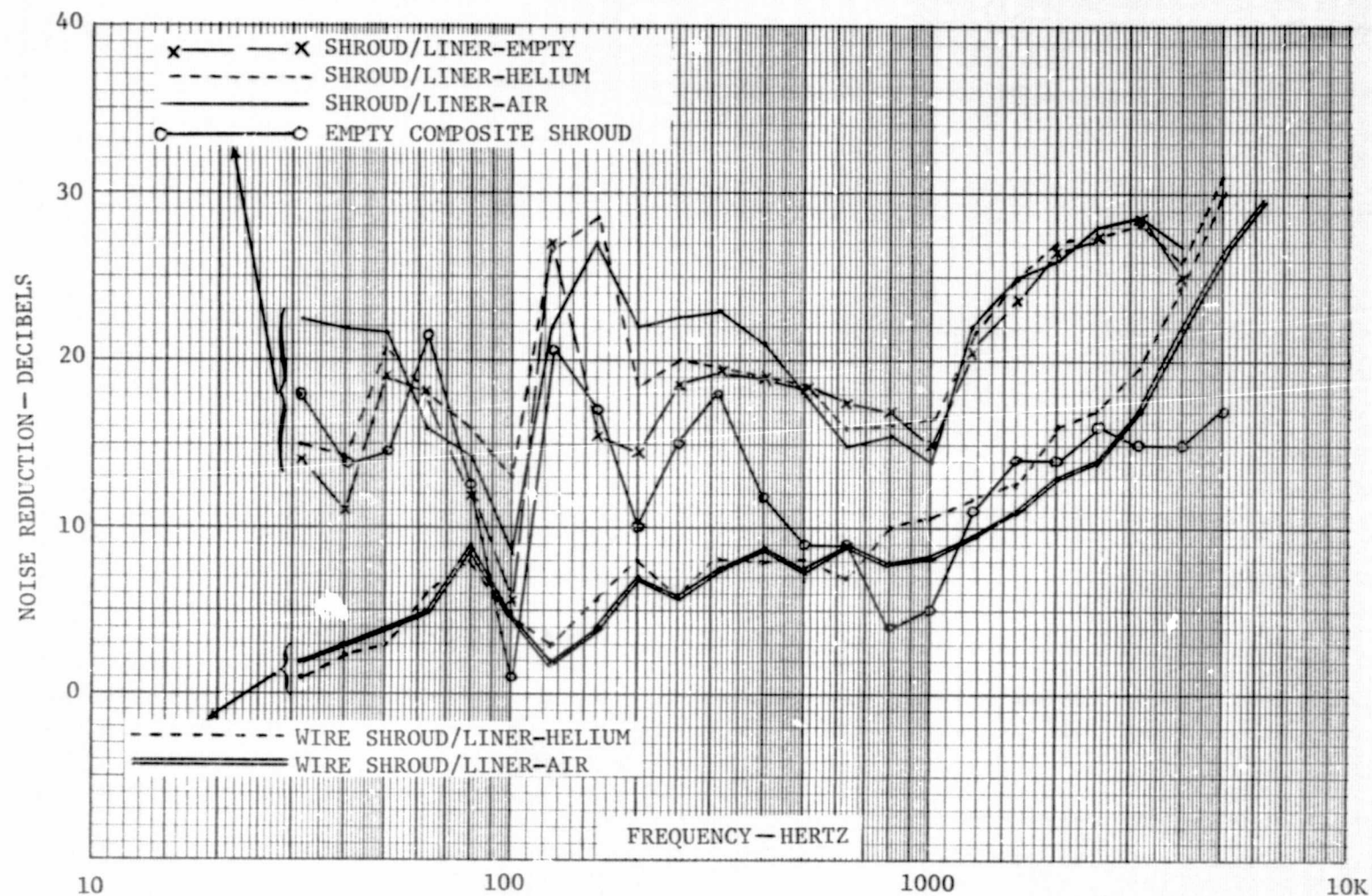


Figure 18. Comparison of Noise Reduction Data for Six Test Configurations.

A1

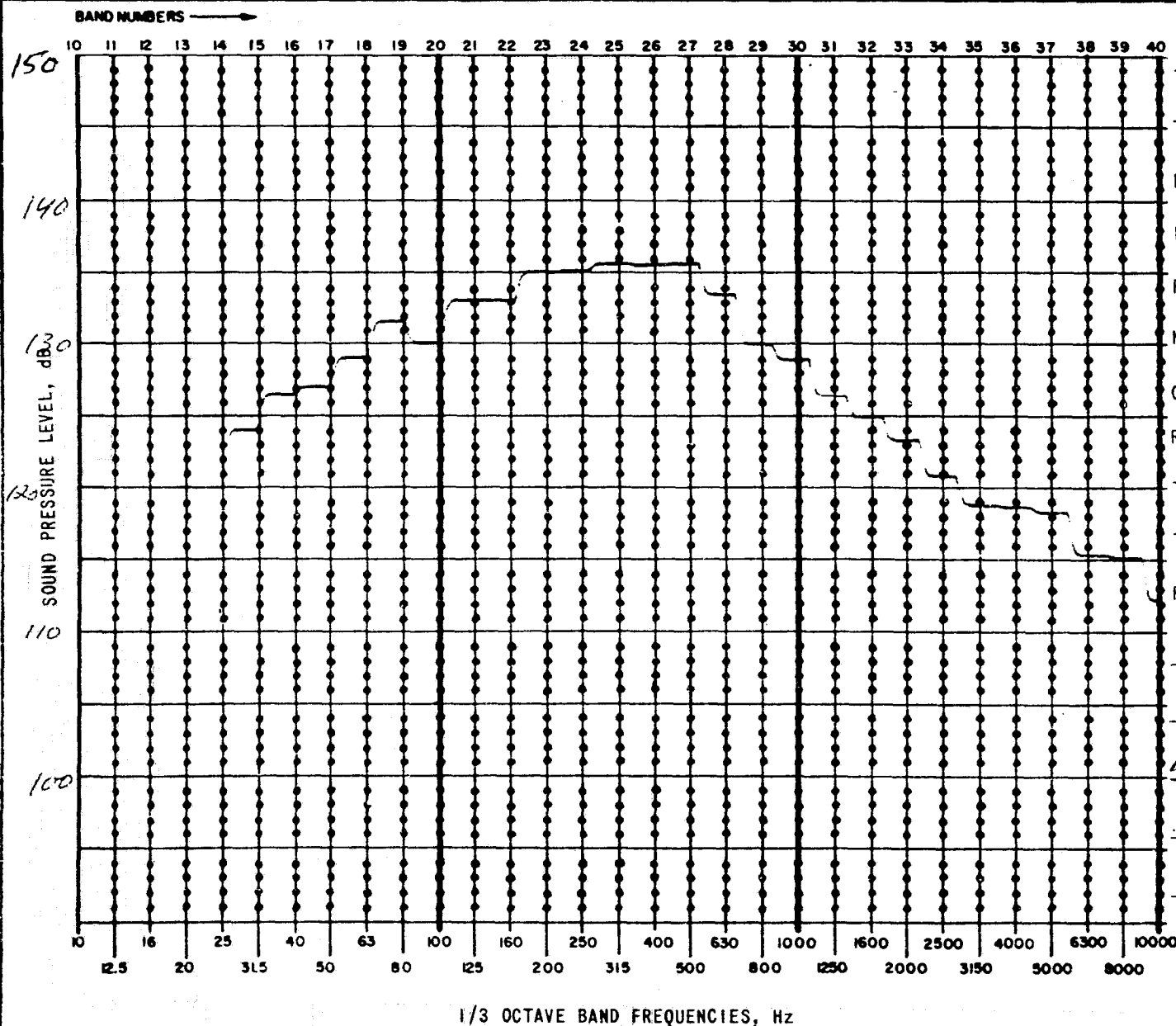
APPENDIX A TEST DATA



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# ACOUSTIC DATA SHEET

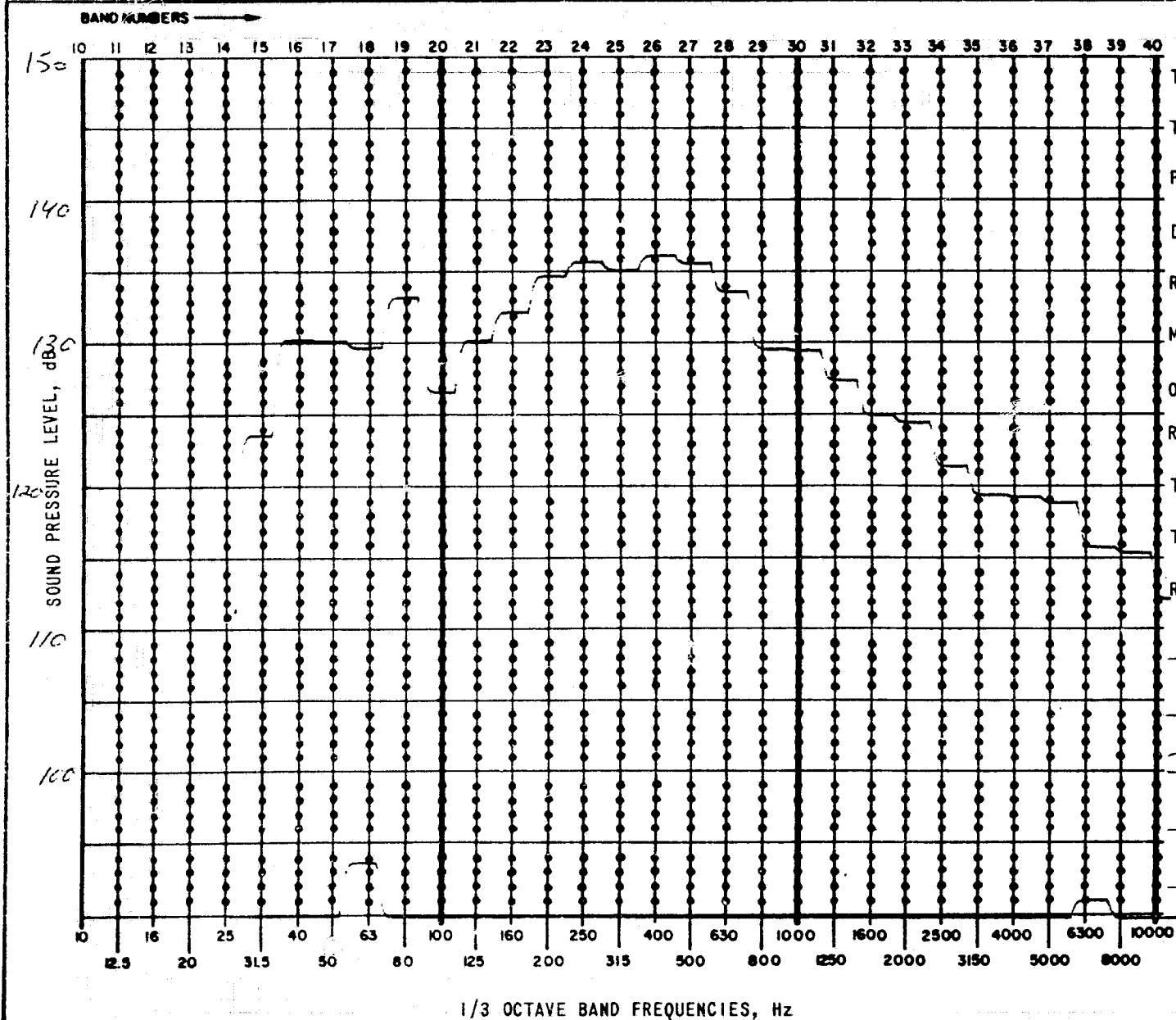


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 RUN DURATION 10 SEC  
 TEST ENGINEER SNYDER  
 TEST TECHNICIAN REEDERSON  
 REMARKS EMPTY SHROUD

Plot #1

EXTERNAL MICROPHONE AVERAGE

# ACOUSTIC DATA SHEET



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TYPE OF TEST EVAL

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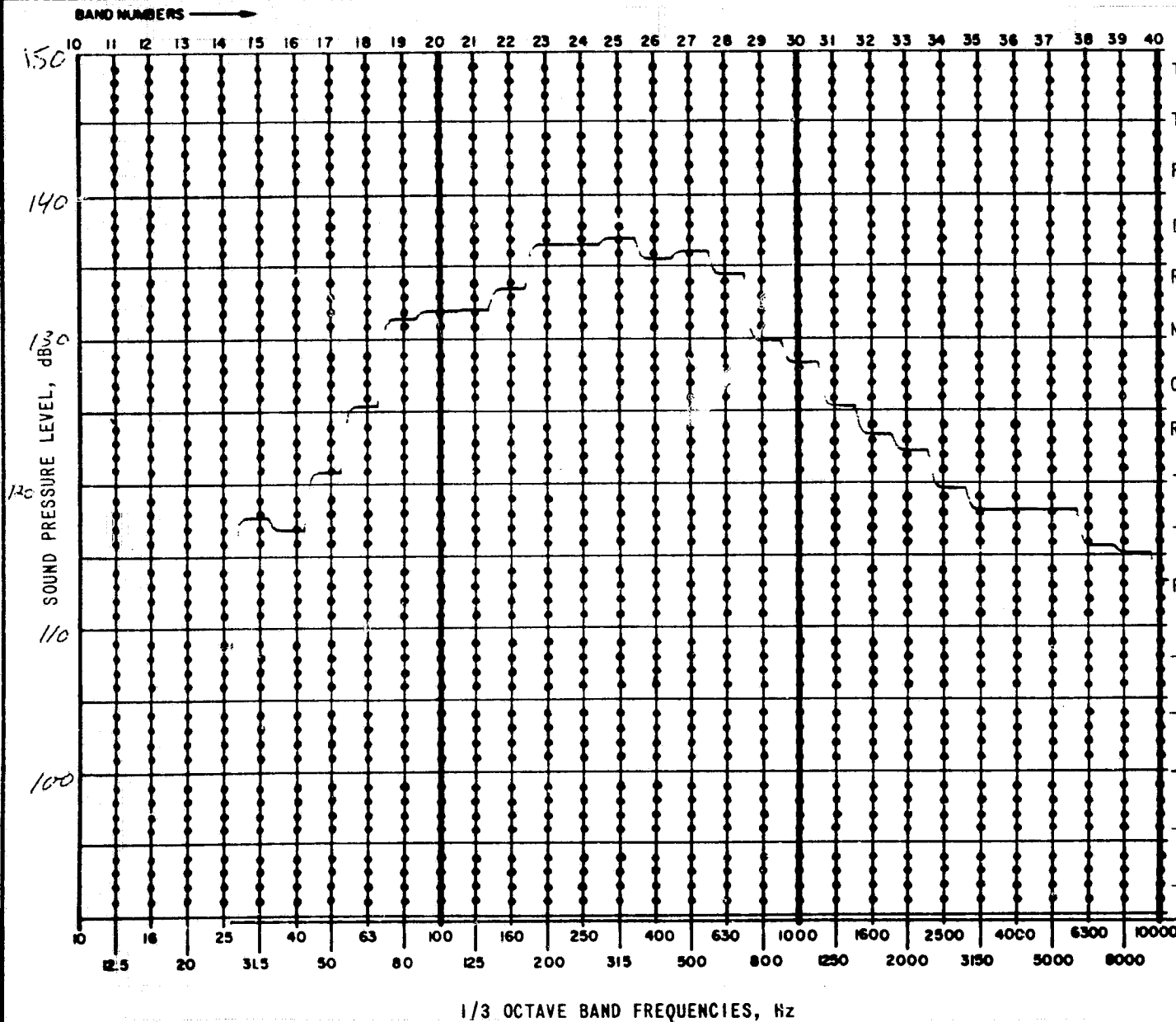
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REMARKS EMPTY SHROUD

Plot #2

-EXTERNAL-

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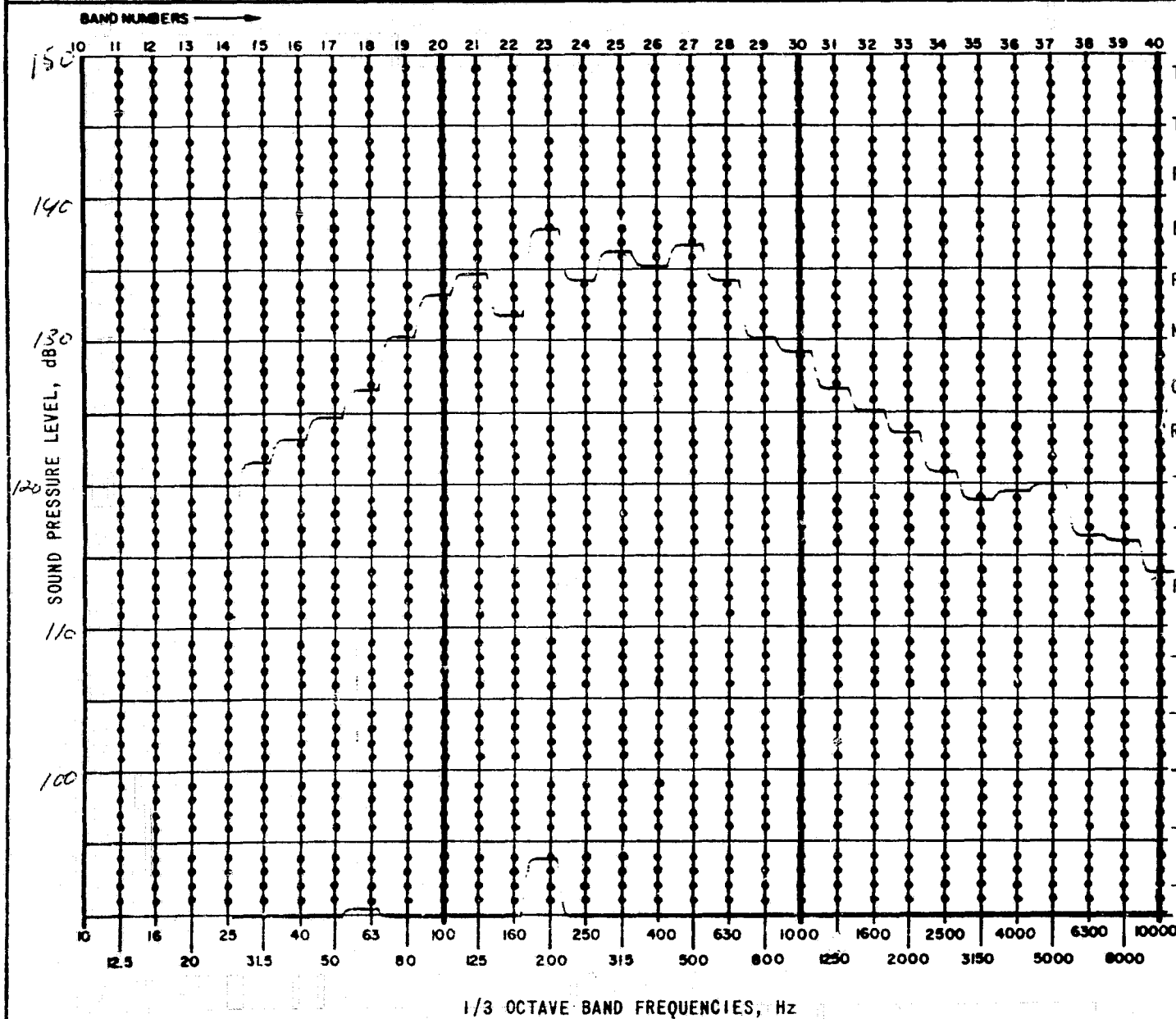
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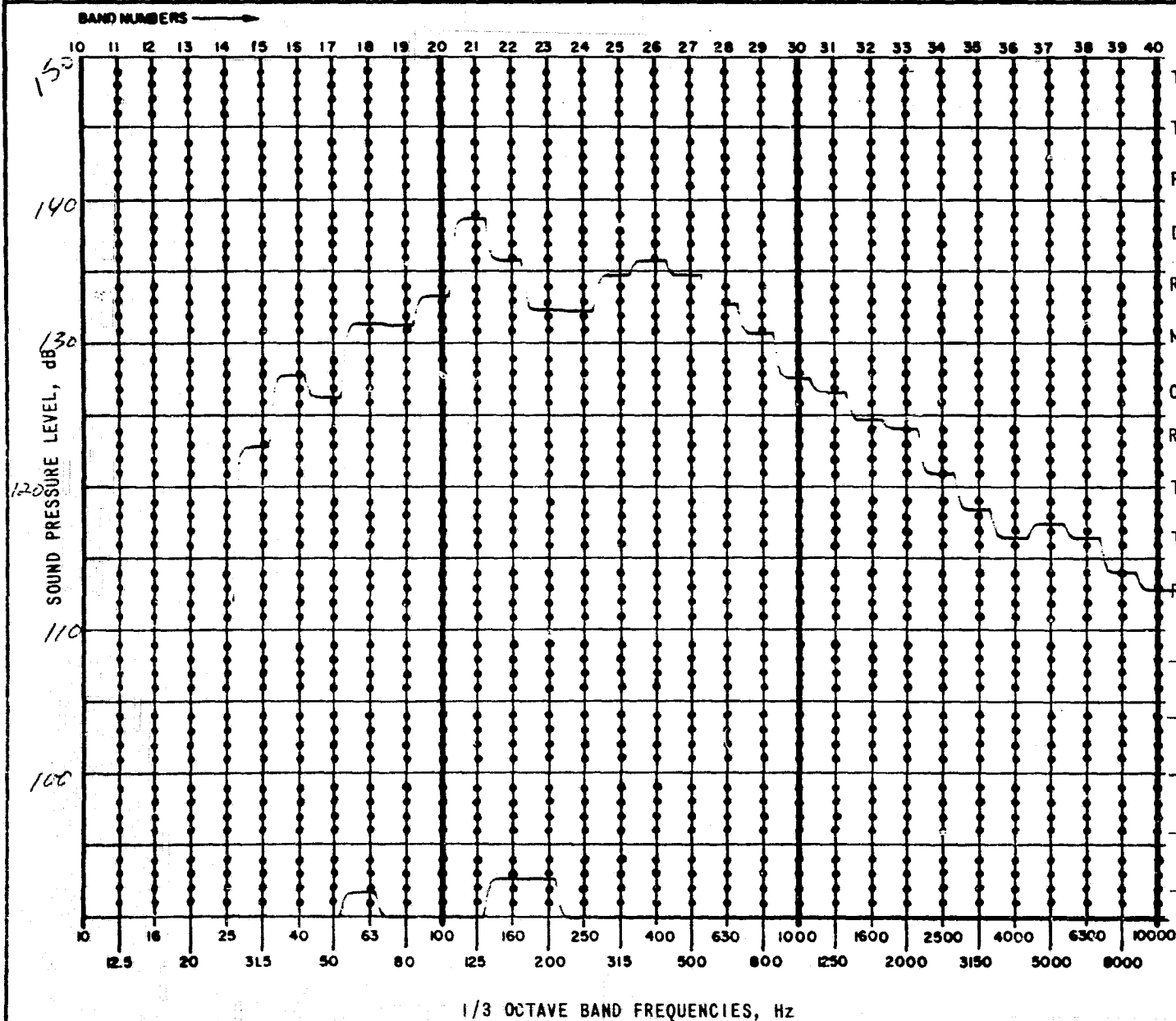
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REMARKS EMPTY SHROUD

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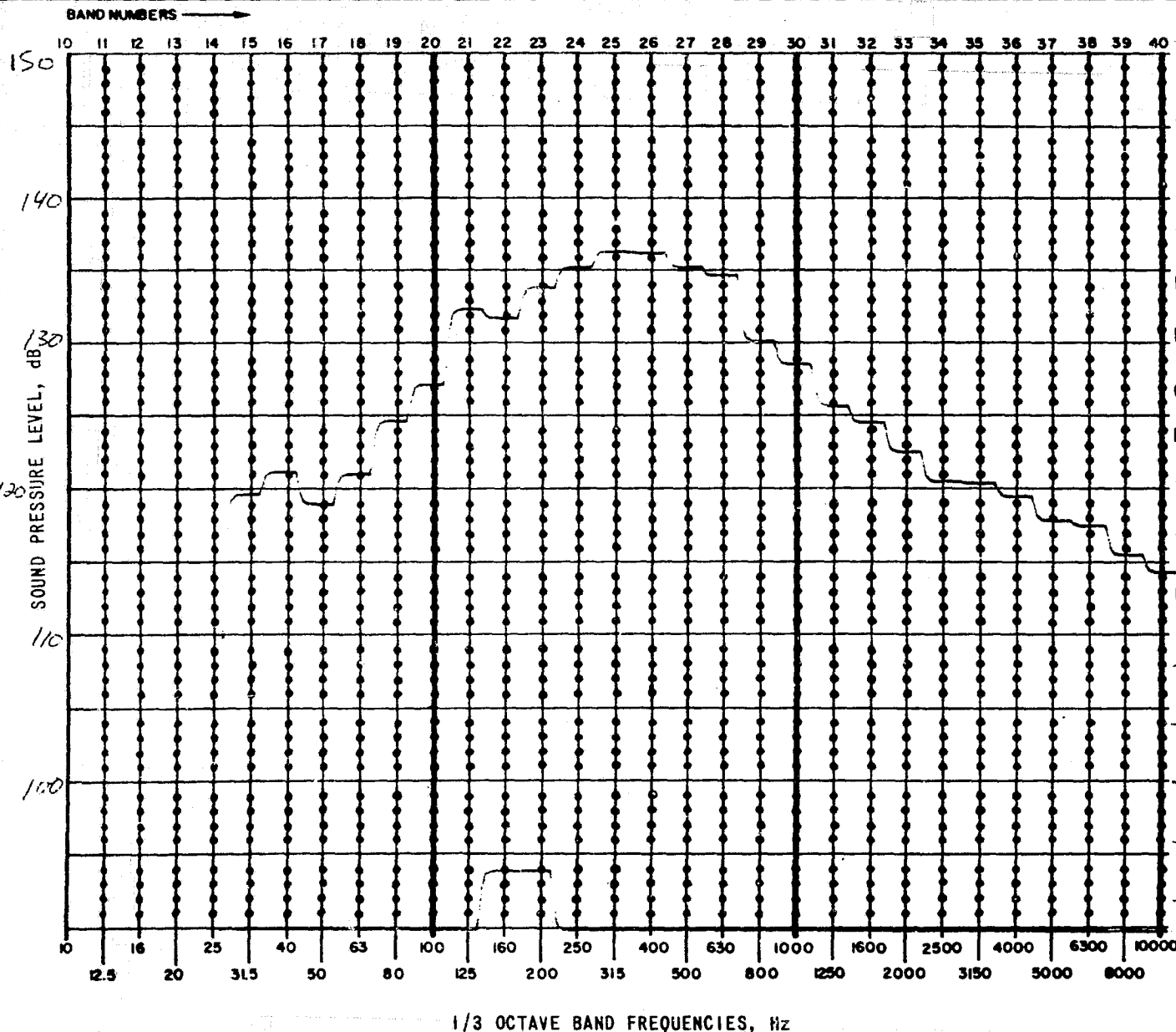
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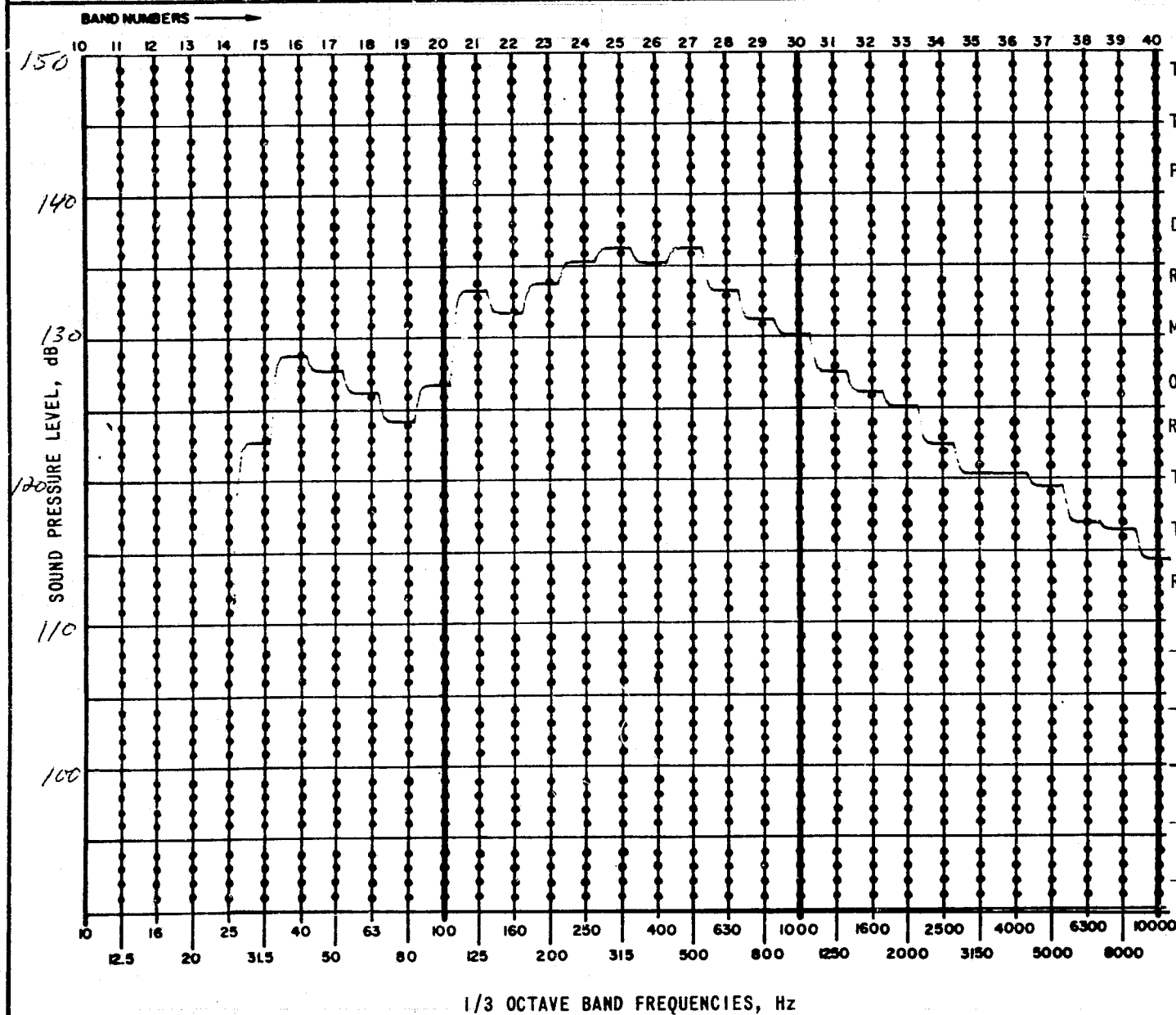
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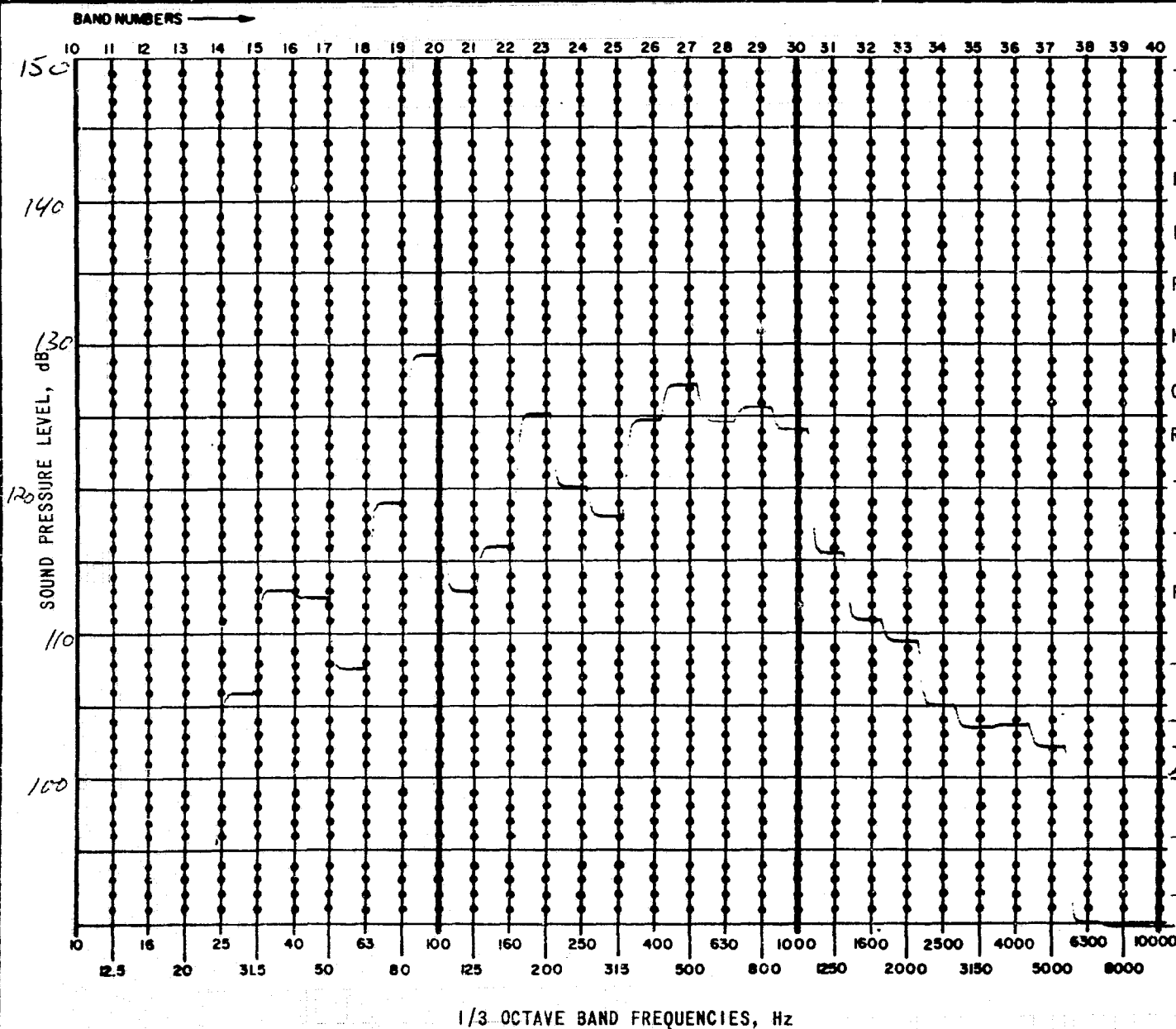
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TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

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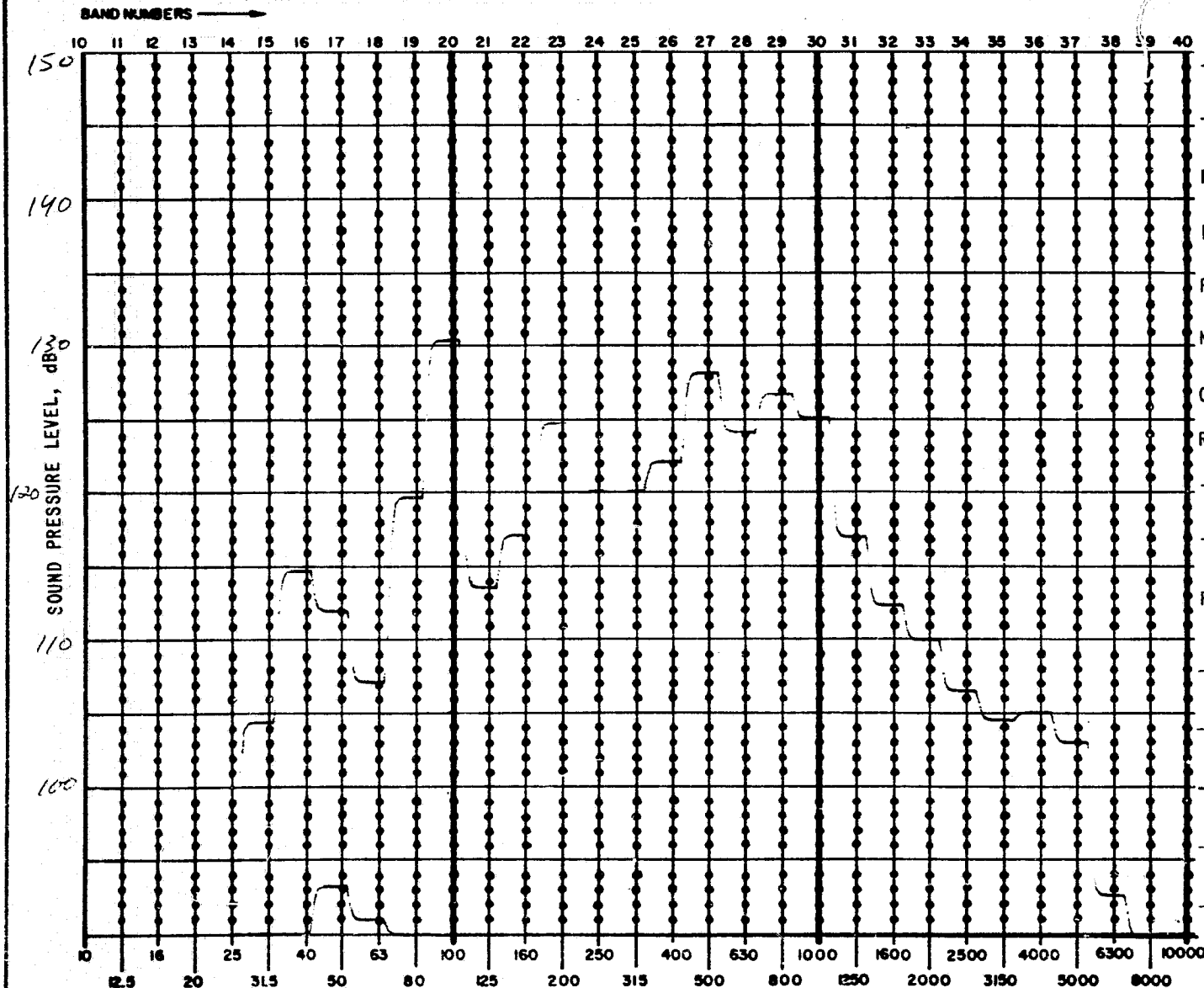
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INTERNAL MICROPHONE

AVERAGE

A10

# ACOUSTIC DATA SHEET



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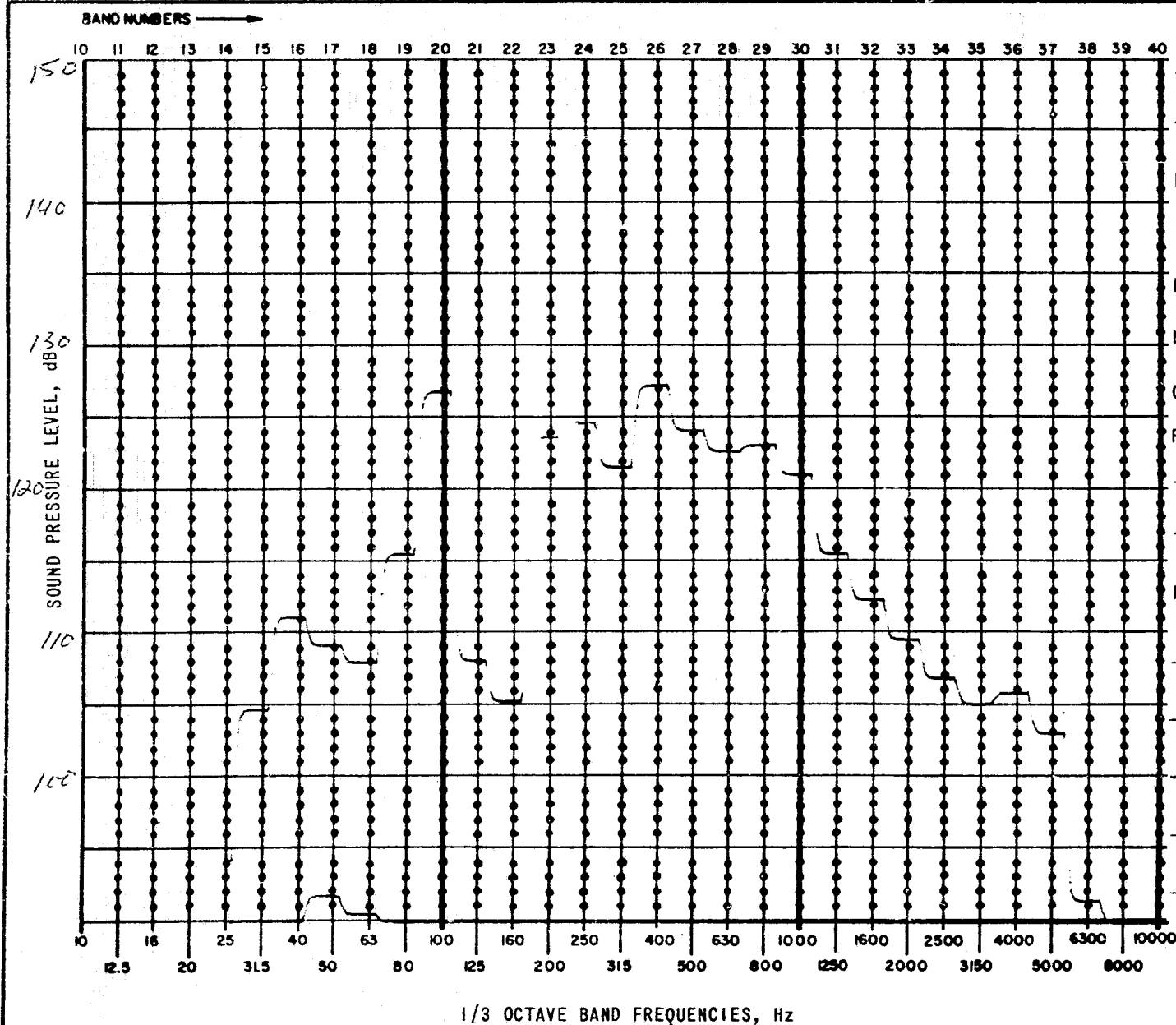
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INTERNAL

# ACOUSTIC DATA SHEET



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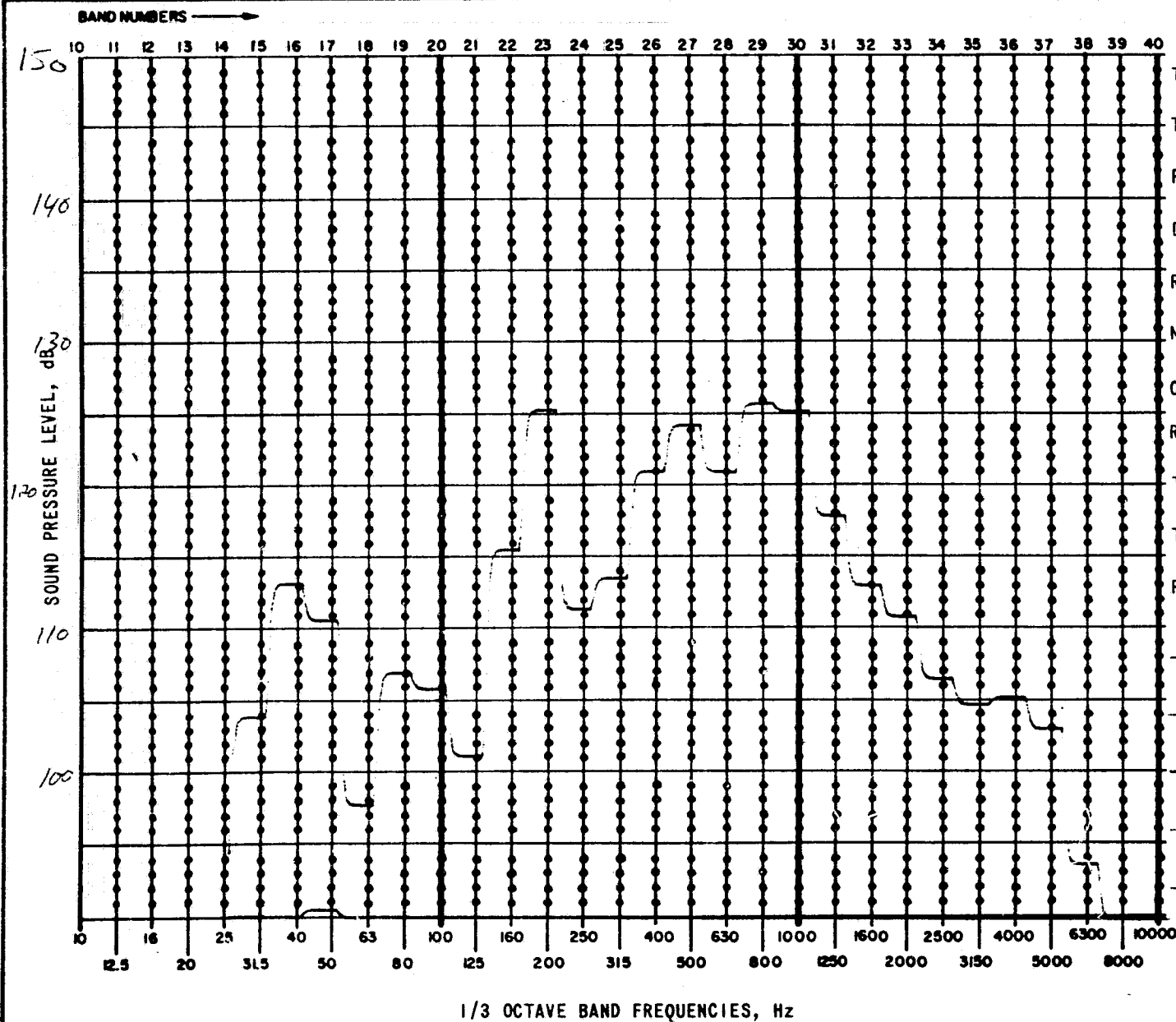
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REMARKS EMPTY SHROUD

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INTERNAL

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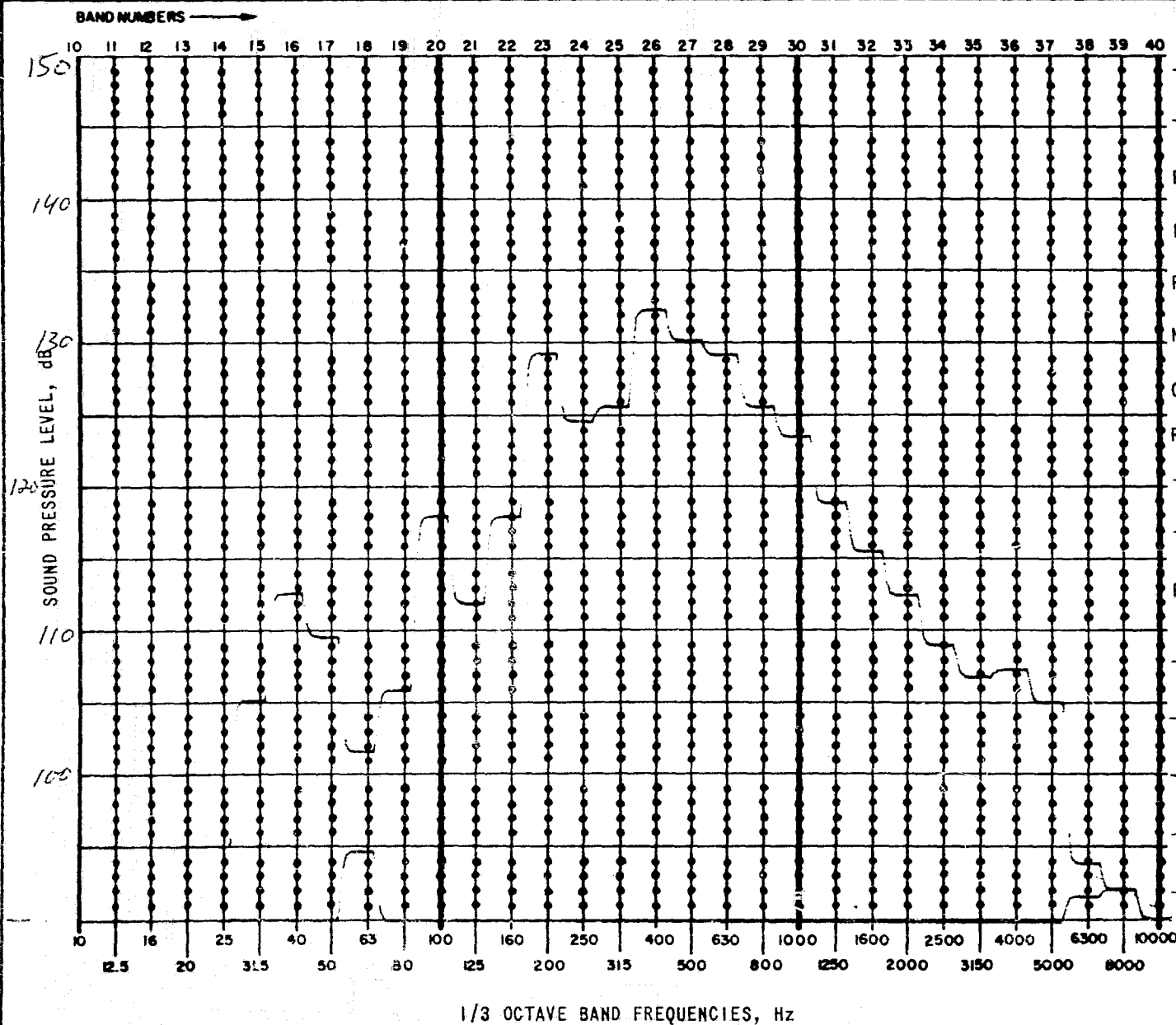
TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS EMPTY SHROUD

A13

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-16-76

RUN NO. 12

MICROPHONE NO. 4

OVERALL LEVEL 137

RUN DURATION 10 SEC.

TEST ENGINEER SNYDER

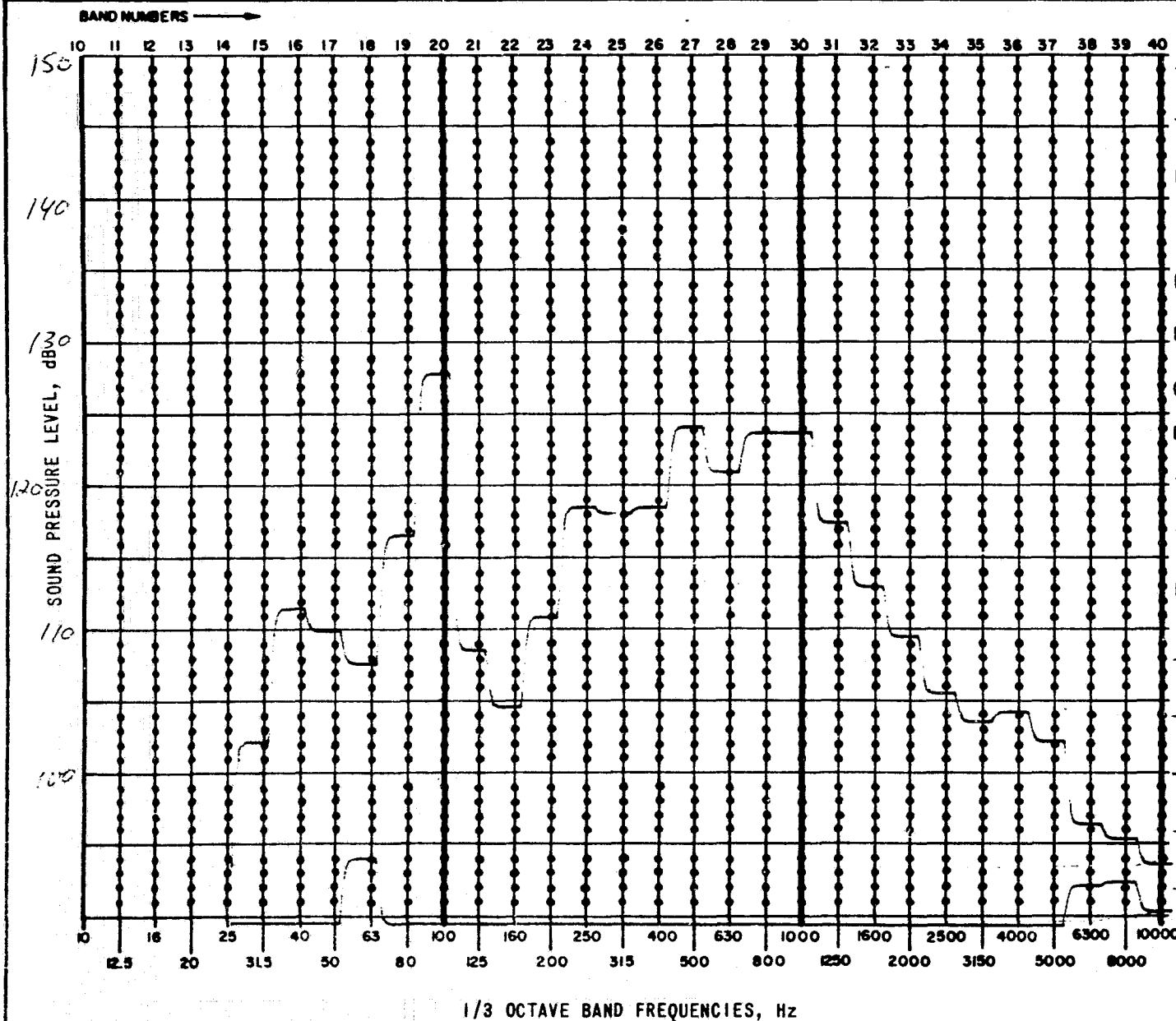
TEST TECHNICIAN ROBERSON

REMARKS EMPTY SHROUD

Plot # 12

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-16-76

RUN NO. 13

MICROPHONE NO. 5

OVERALL LEVEL 132

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

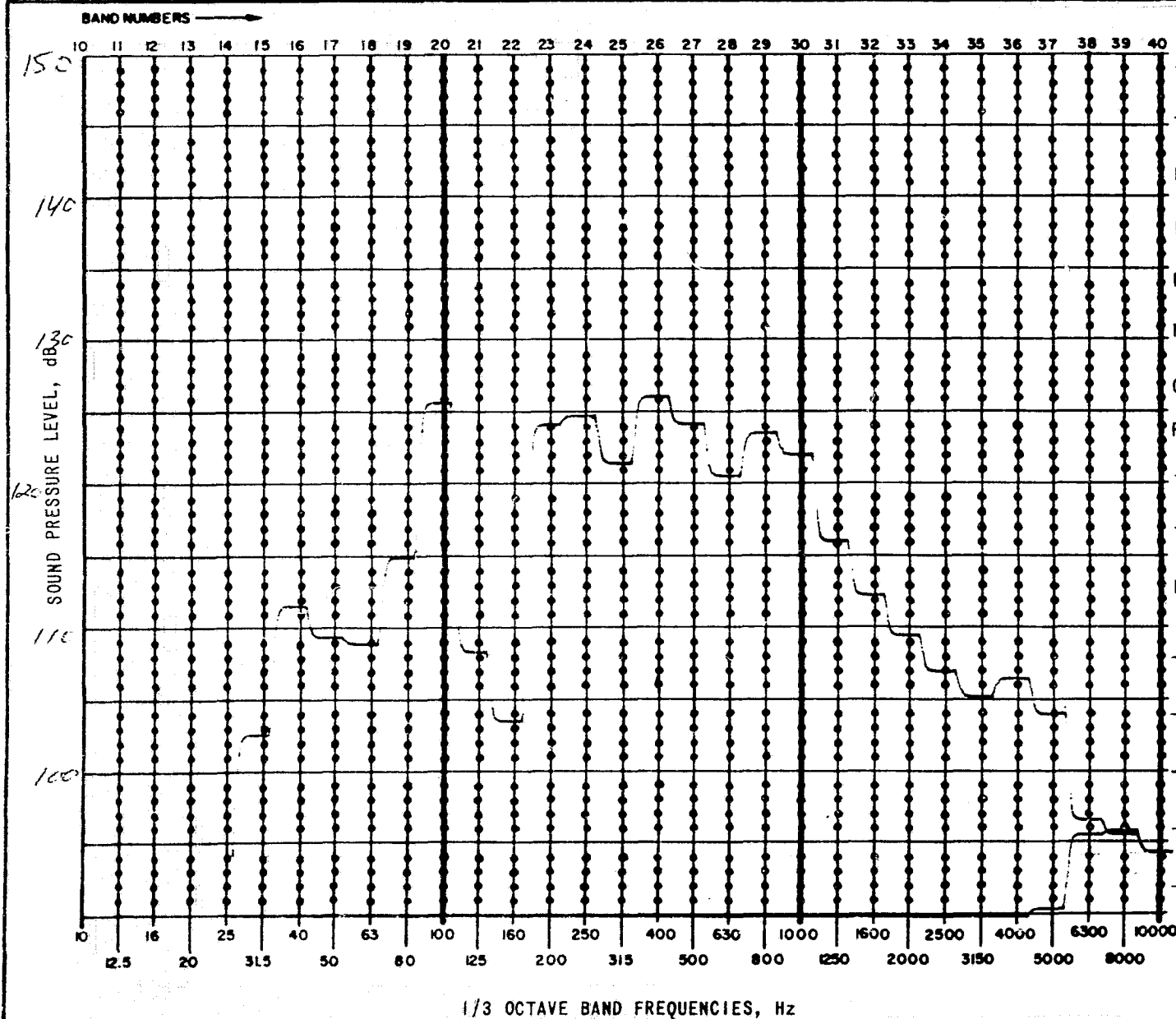
REMARKS Empty Shroud

Plot #13

INTERNAL

115

# ACOUSTIC DATA SHEET



TEST ITEM Comp. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-16-76

RUN NO. 14

MICROPHONE NO. 6

OVERALL LEVEL 133.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

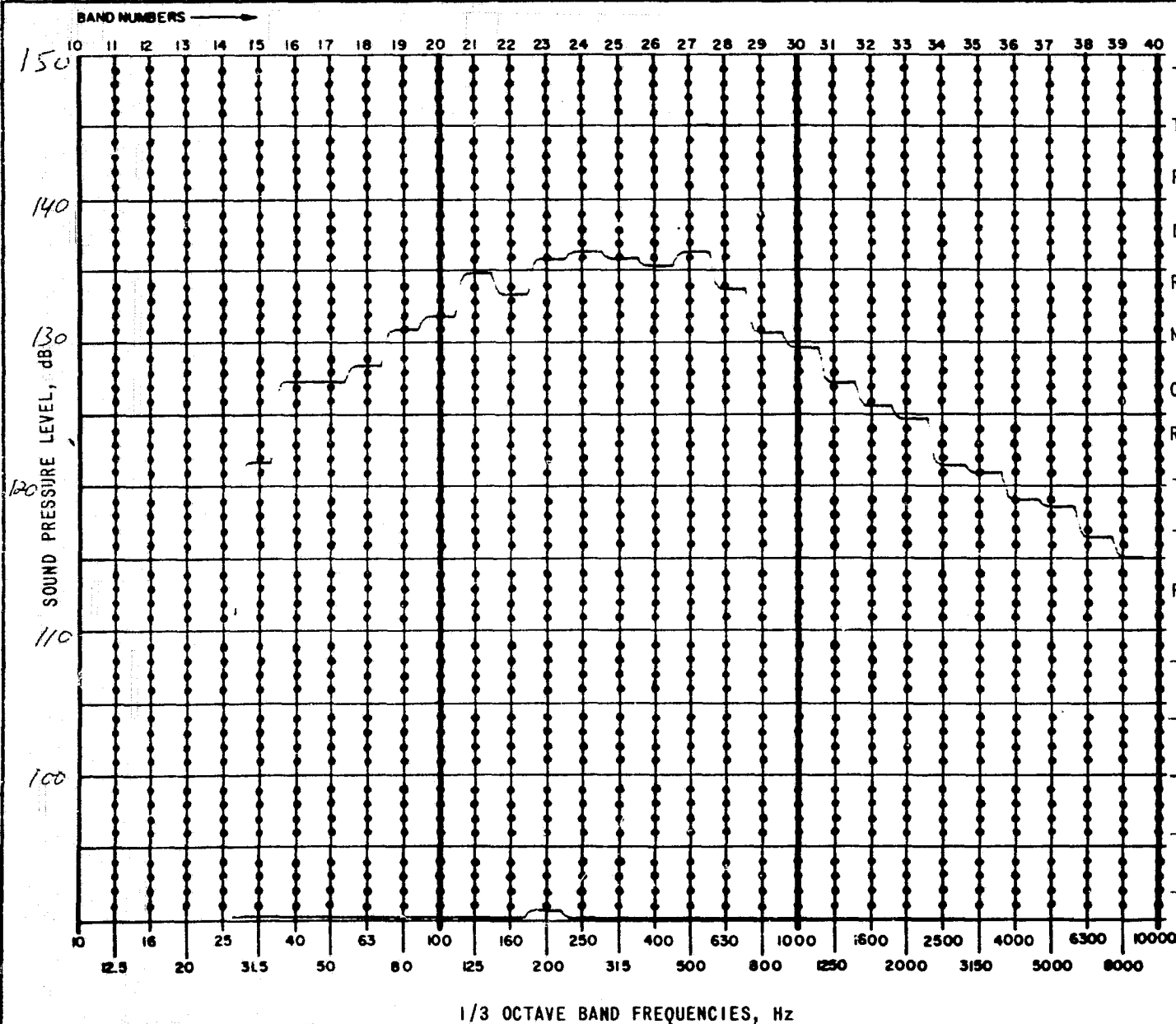
TEST TECHNICIAN ROBERSON

REMARKS EMPTY SHROUD

Plot #14

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM Cenir. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 15

MICROPHONE NO. 1M-6M AUG

OVERALL LEVEL 145 ON 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

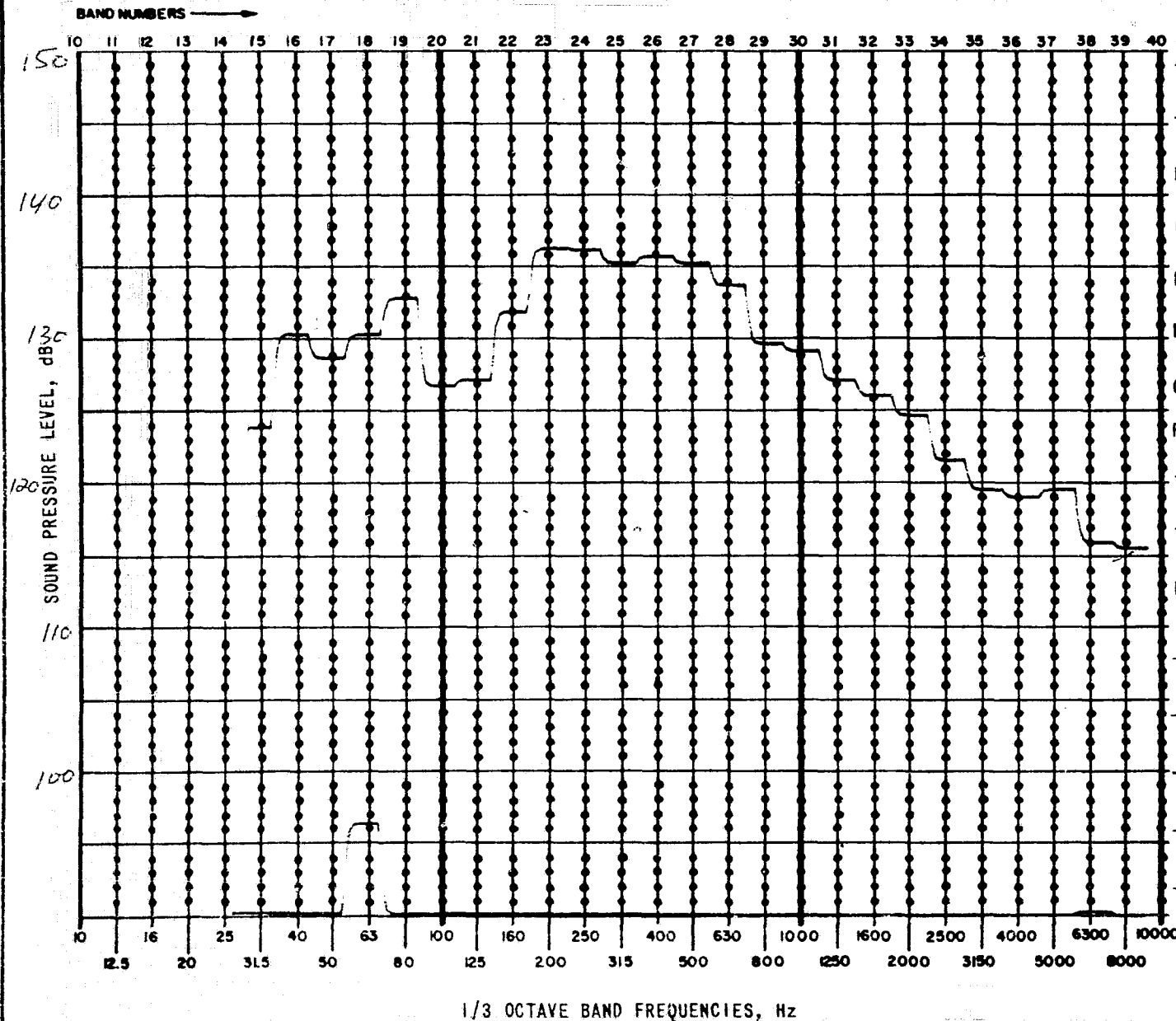
Plot # 15

EXTERNAL MICROPHONE

AVERAGE



# ACOUSTIC DATA SHEET



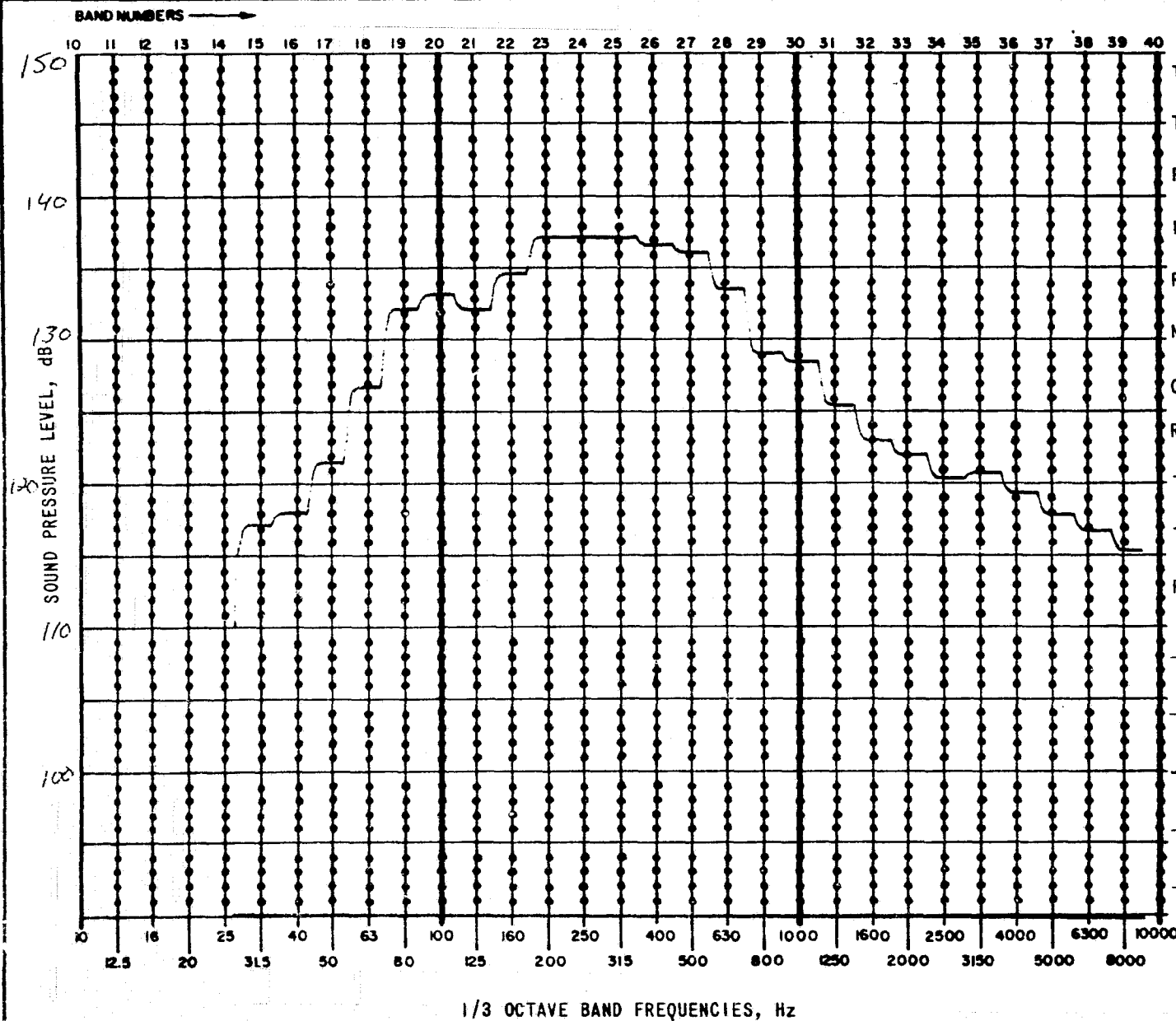
TEST ITEM Comp. Shroud  
 TYPE OF TEST EVAL  
 PROGRAM SS  
 DATE 9-15-76  
 RUN NO. 23  
 MICROPHONE NO. 1M  
 OVERALL LEVEL 145  
 RUN DURATION 10 SEC  
 TEST ENGINEER SNYDER  
 TEST TECHNICIAN ROBERSON  
 REMARKS BAGS EVACUATED  
Plot #16

EXTERNAL

A18

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL.

PROGRAM S.S

DATE 9-15-76

RUN NO. 24

MICROPHONE NO. 2M

OVERALL LEVEL 146

RUN DURATION 10 SEC.

TEST ENGINEER SNYDER

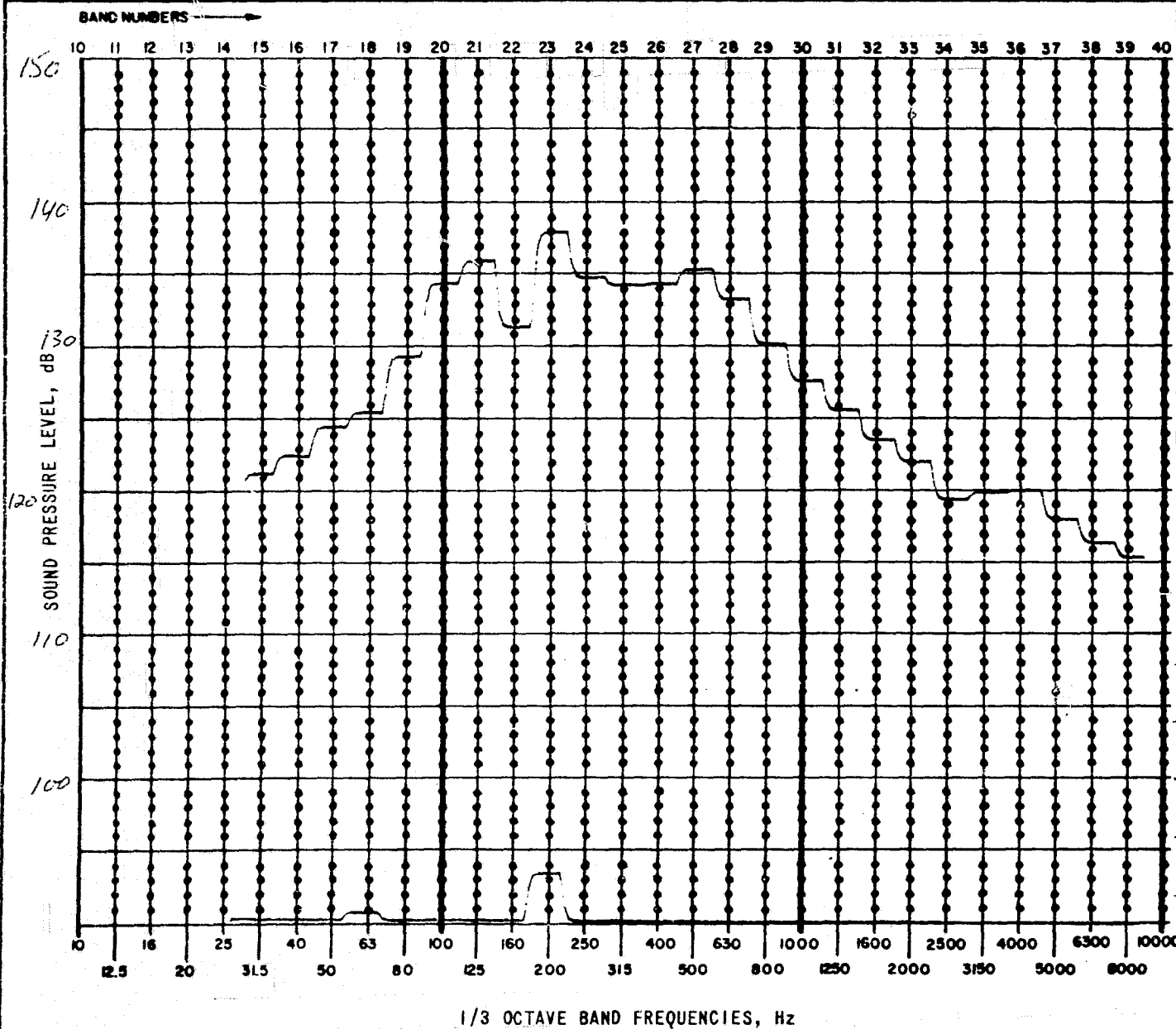
TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

Plot #17

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 25

MICROPHONE NO. 3M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

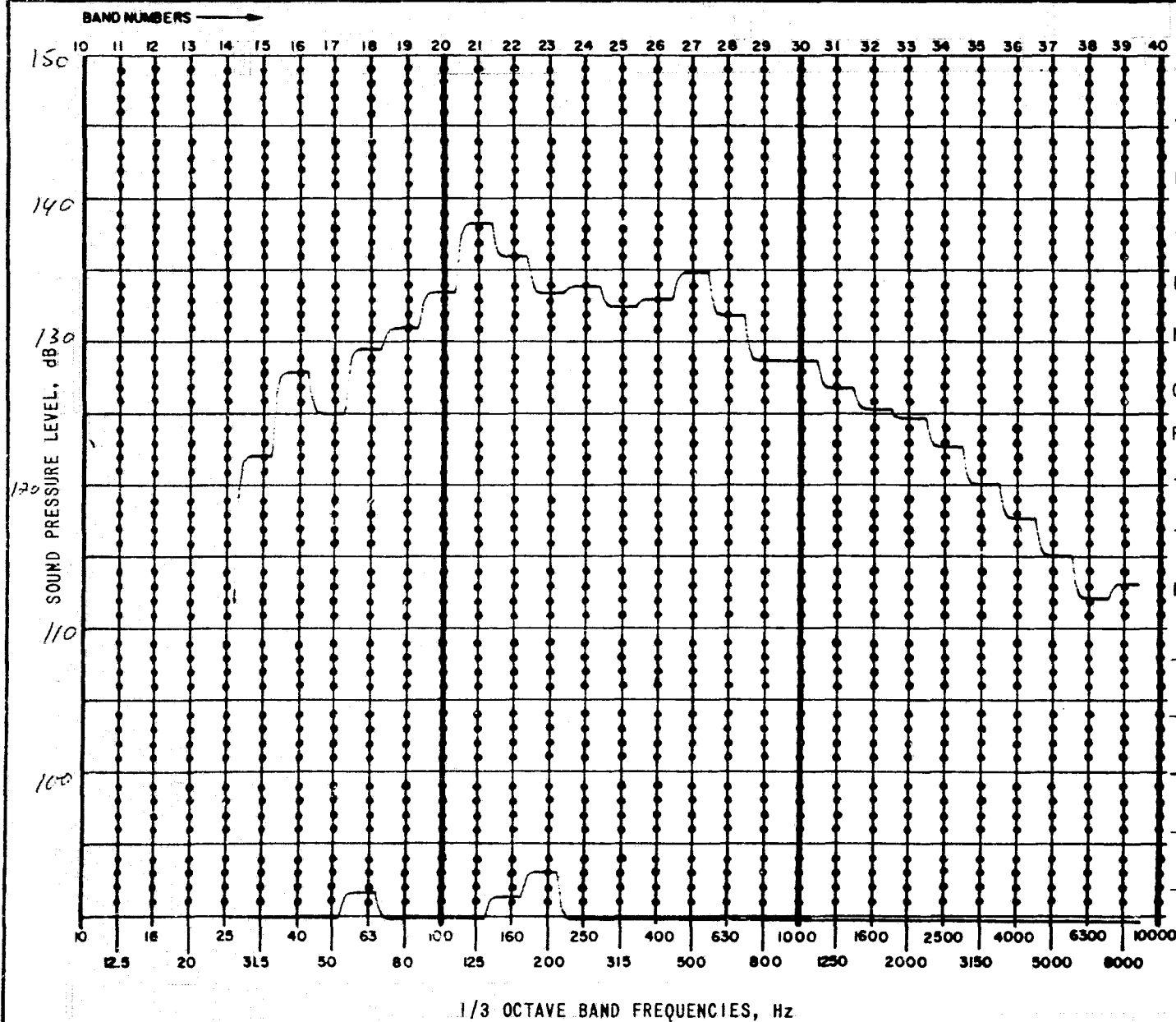
TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

Plot # 18

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP SHREDD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 26

MICROPHONE NO. 4M

OVERALL LEVEL 145

RUN DURATION 10 SEC.

TEST ENGINEER JAYDER

TEST TECHNICIAN ROBERSON

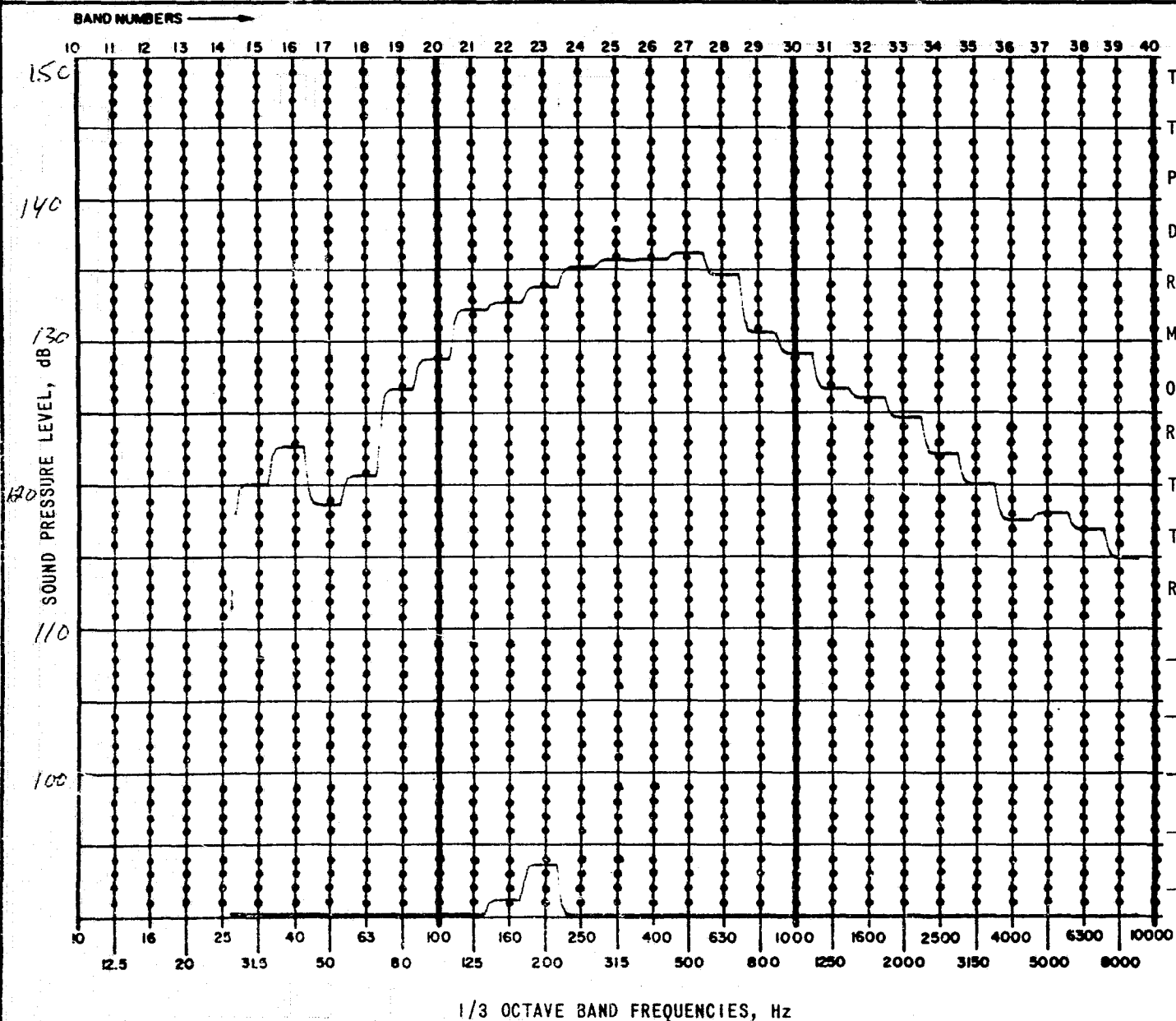
REMARKS BAGS EVACUATED

Plot #19

EXTERNAL

A21

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 27

MICROPHONE NO. 5M

OVERALL LEVEL 144

RUN DURATION 10SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

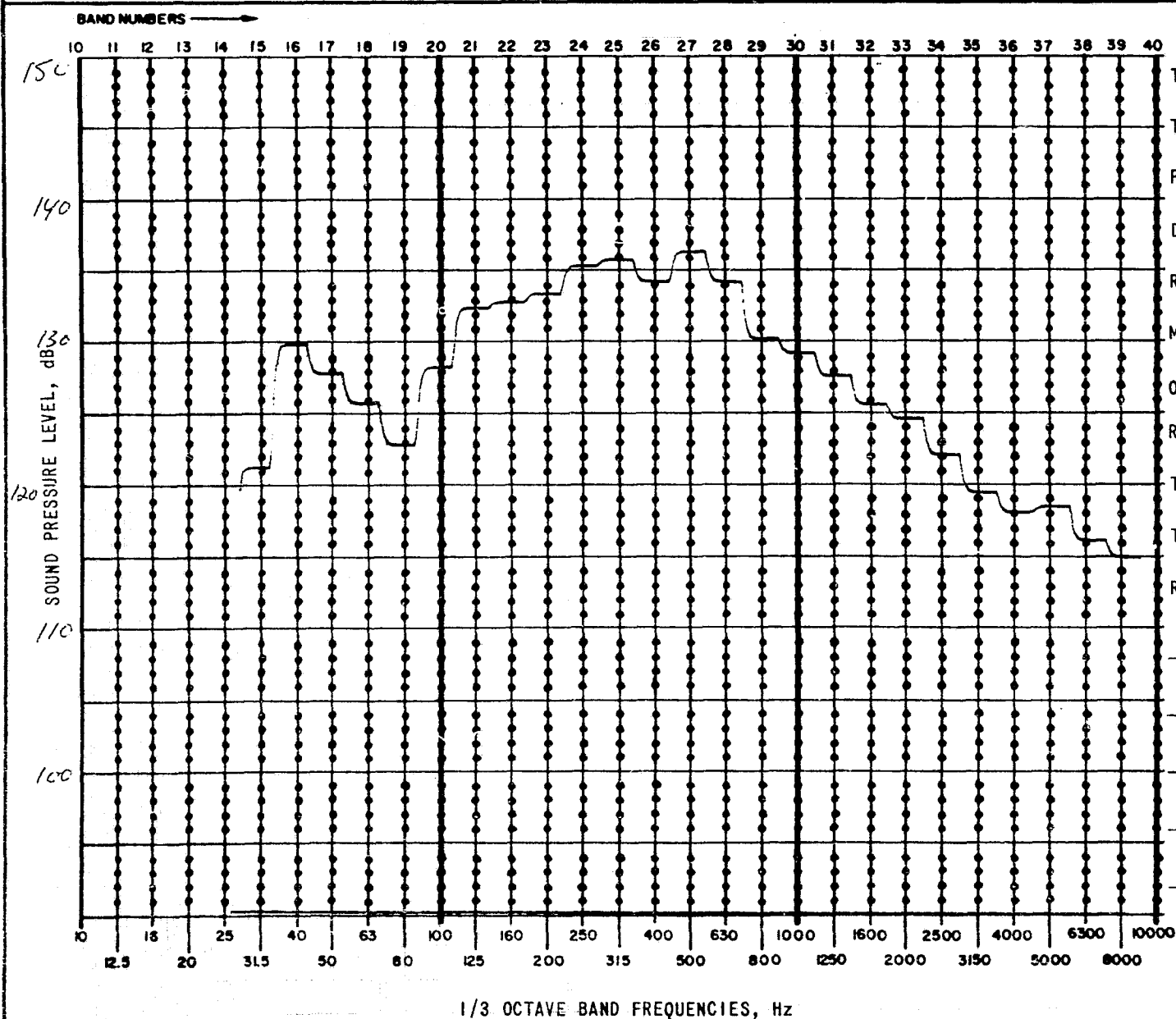
Plot # 20

EXTERNAL

A22

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 28

MICROPHONE NO. 6M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERTSON

REMARKS PACS EVALUATED

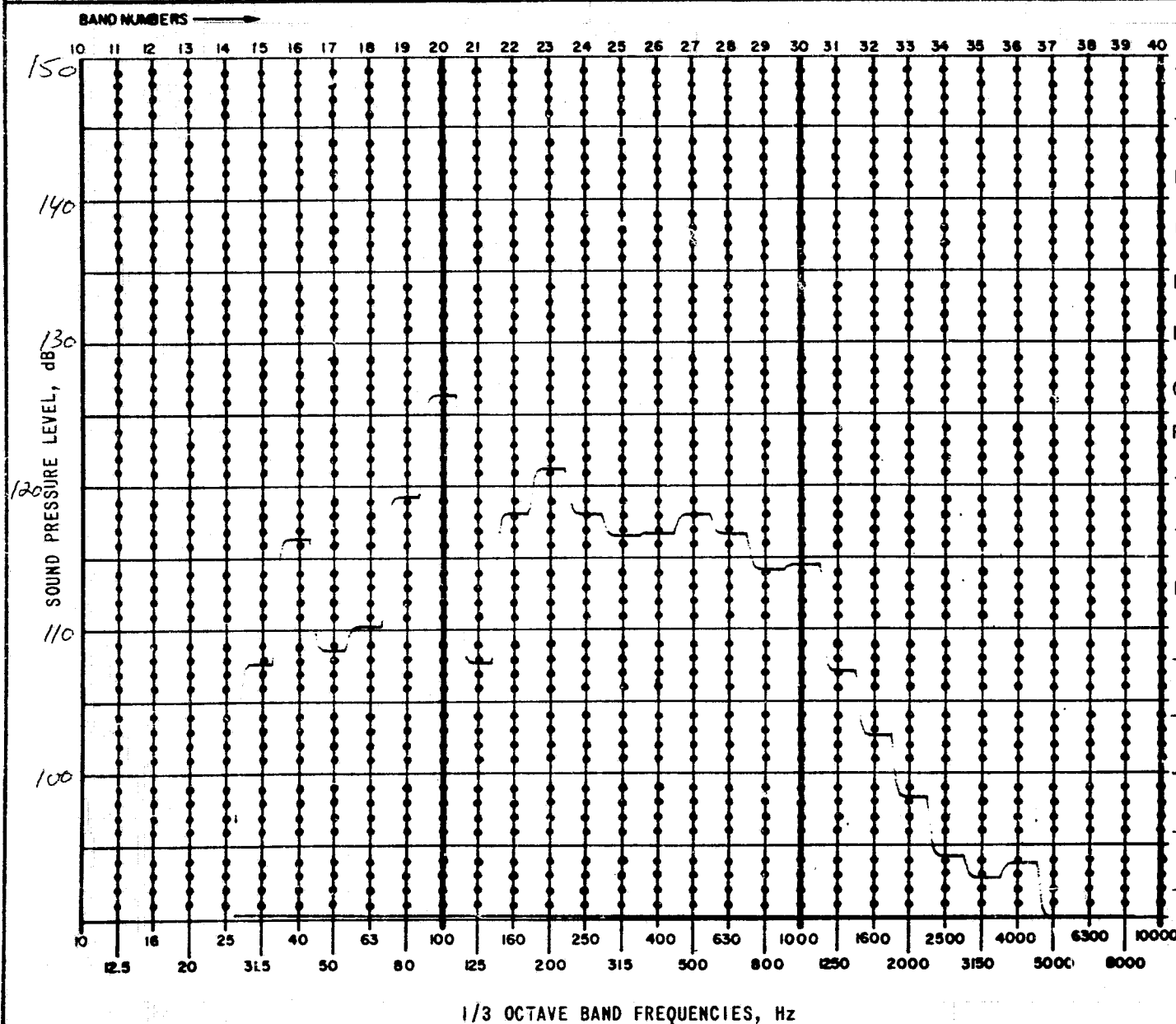
Plot # 21

EXTERNAL

A23



# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 16

MICROPHONE NO. 1-6 AUG.

OVERALL LEVEL 145 ON 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

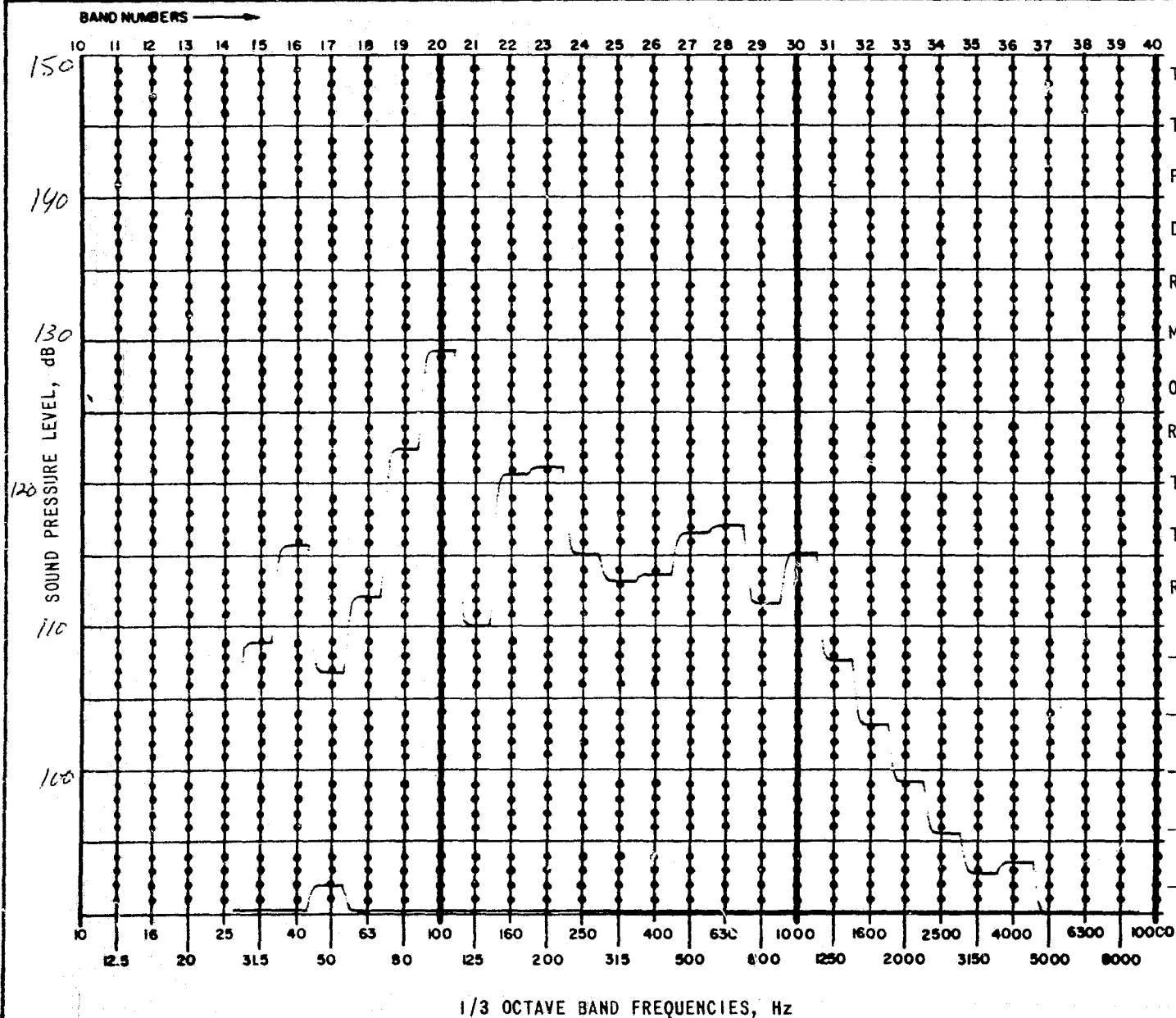
REMARKS BAGS EVALUATED

Plot # 22

INTERNAL MICROPHONE

AVERAGE

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHIELD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 17

MICROPHONE NO. 1

OVERALL LEVEL 131

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

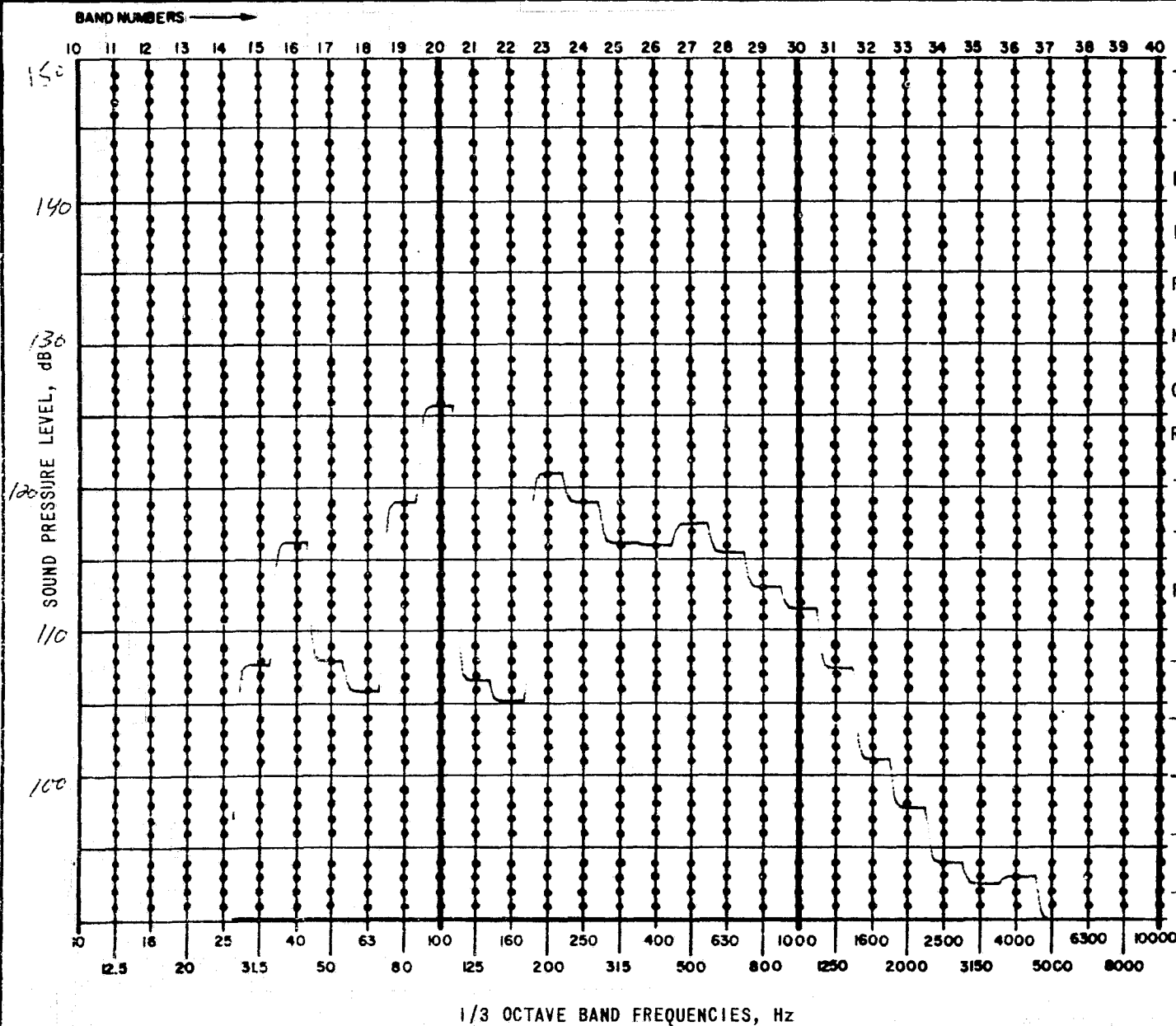
REMARKS BAGS EVACUATED

Plot No. 23

INTERNAL

A25

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Sound

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 18

MICROPHONE NO. 2

OVERALL LEVEL 130

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

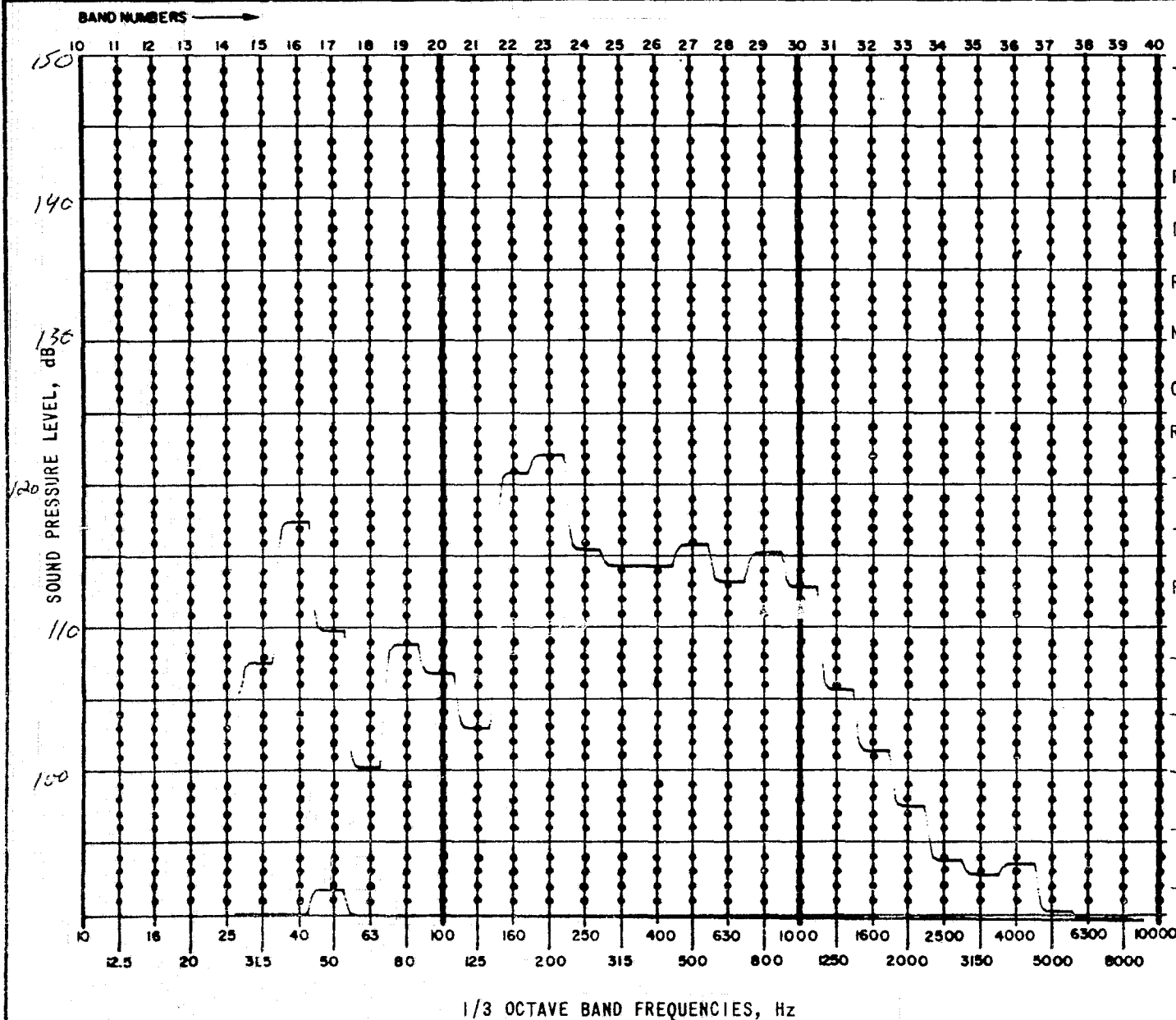
TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

Plot # 24

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 19

MICROPHONE NO. 3

OVERALL LEVEL 128

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

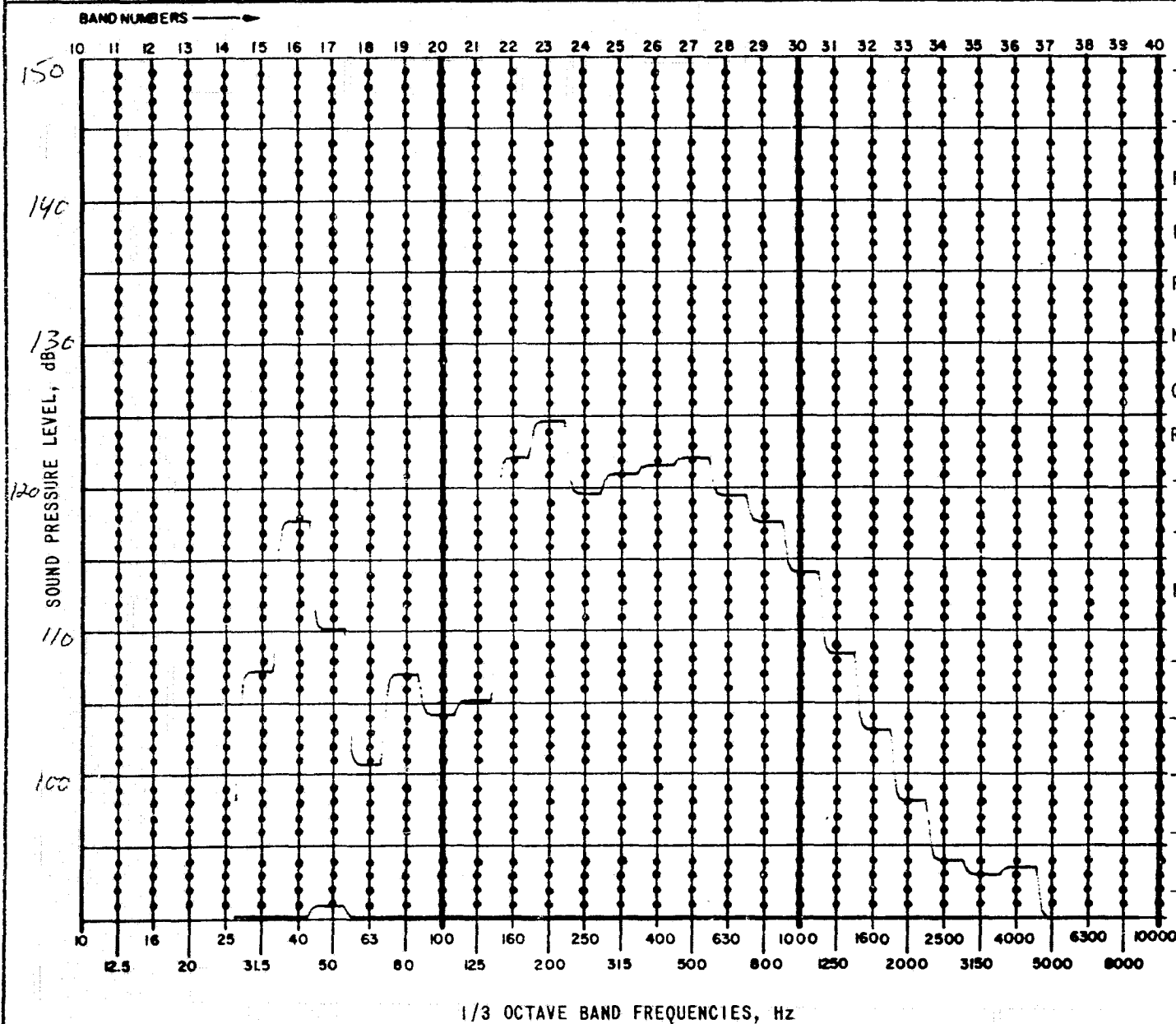
TEST TECHNICIAN ROBERSON

REMARKS BAGS EVALUATED

Plot # 25

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO 20

MICROPHONE NO. 4

OVERALL LEVEL 132

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

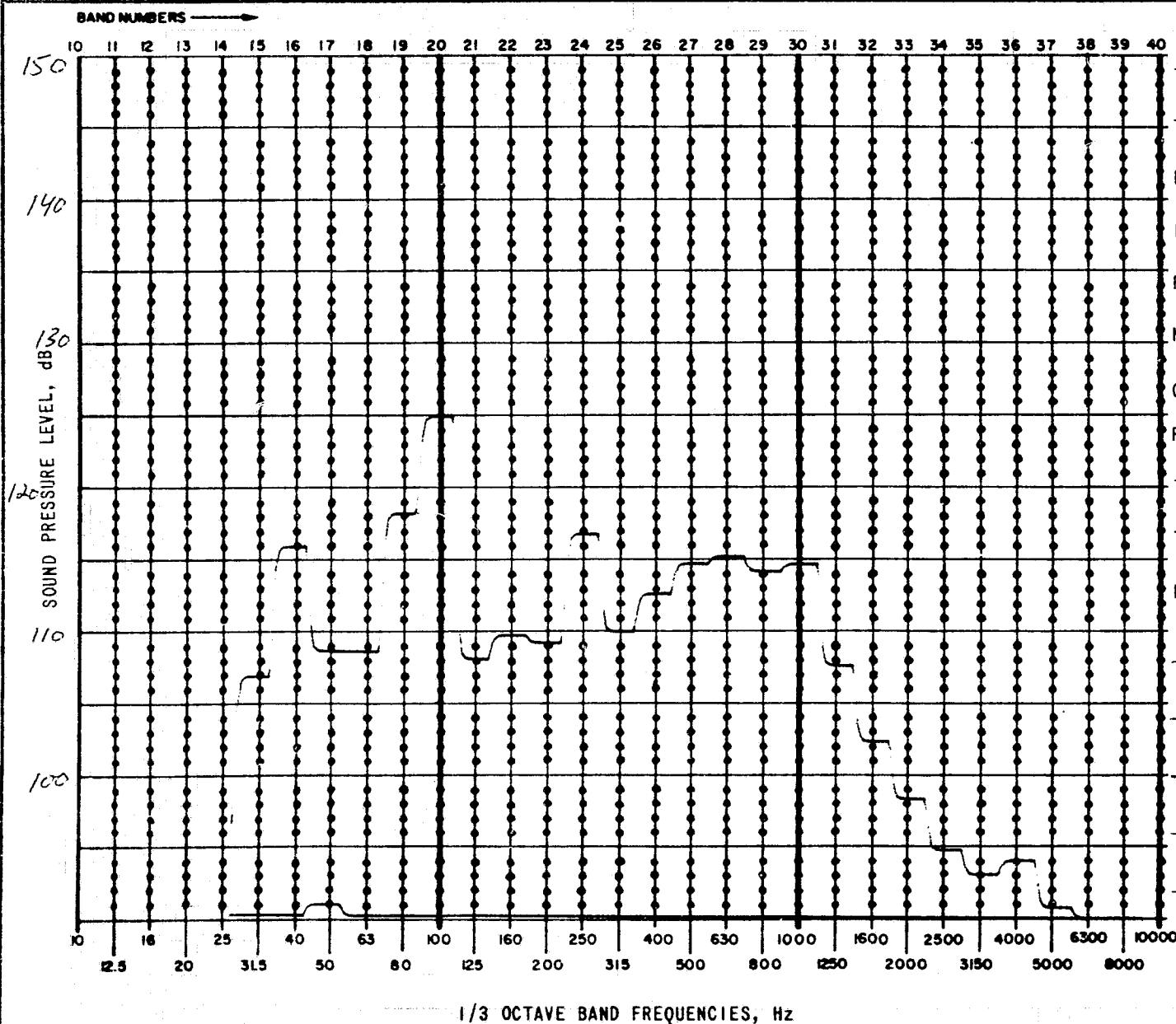
TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

Pilot #16

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM Comp. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 21

MICROPHONE NO. 5

OVERALL LEVEL 128

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

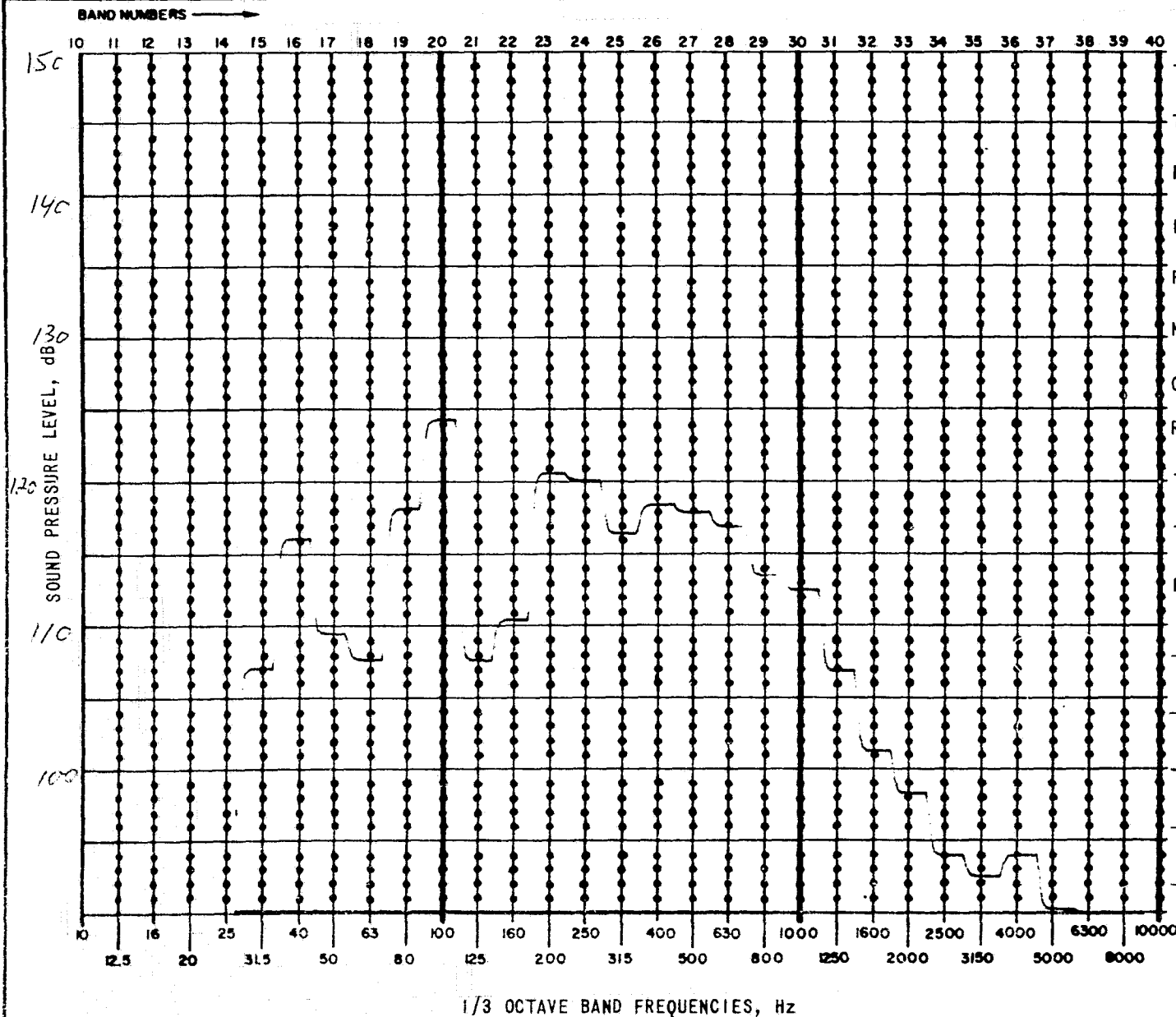
TEST TECHNICIAN ROBERSON

REMARKS BAGS EVALUATED

Plot # 27

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM 55

DATE 9-15-76

RUN NO. 22

MICROPHONE NO. 6

OVERALL LEVEL 130

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS BAGS EVACUATED

Plot # 28

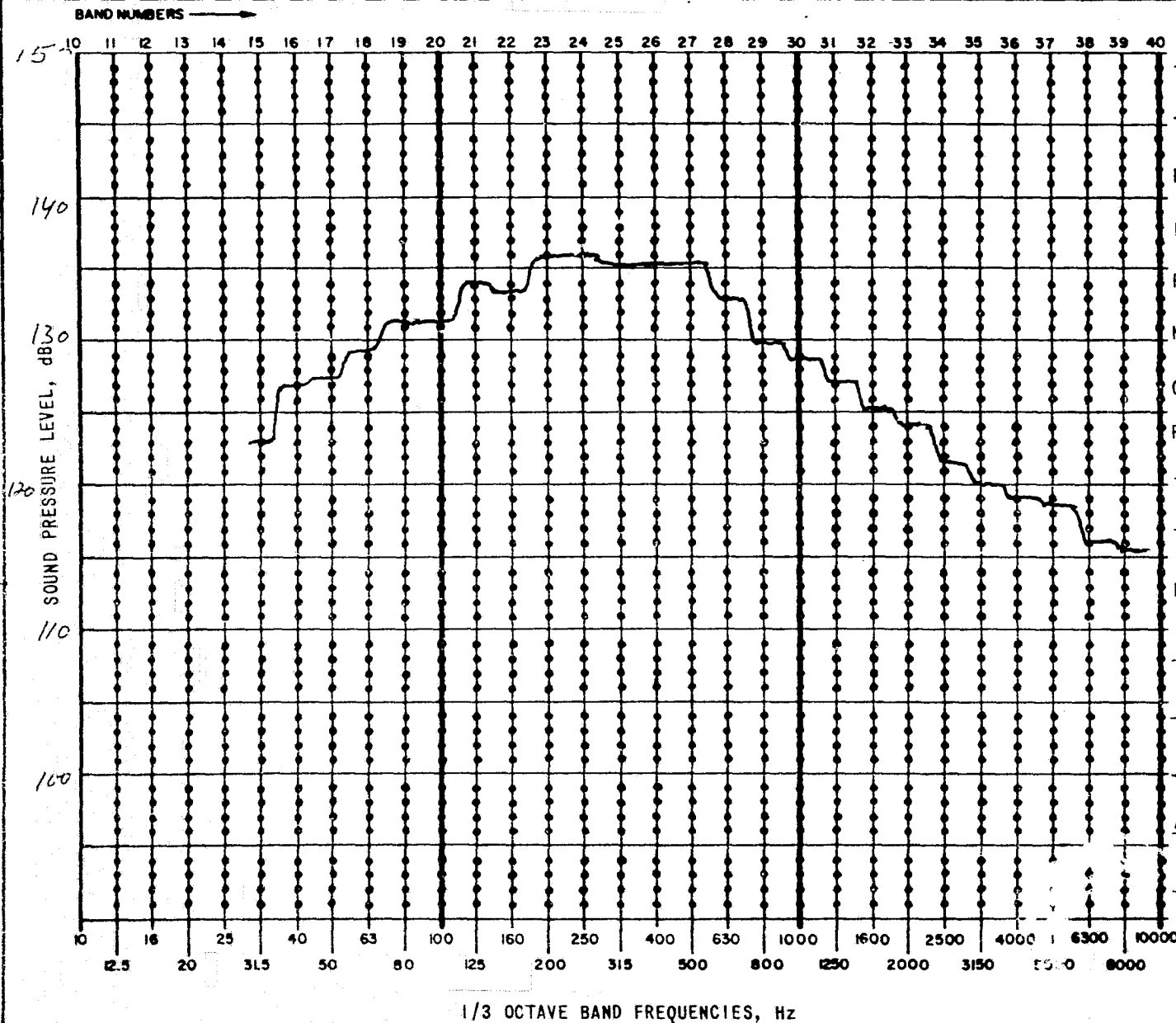
INTERNAL

A30

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR



# ACOUSTIC DATA SHEET



TEST ITEM COMP SHROUD

TYPE OF TEST ENV.

PROGRAM SE

DATE 9-15-76

RUN NO. 1

MICROPHONE NO. 1M-6A-AUG

OVERALL LEVEL 145 ON #1M

RUN DURATION 10 SEC

TEST ENGINEER SHADER

TEST TECHNICIAN ROBERSON

REMARKS AIR IN JACKET  
3448. N/m<sup>2</sup>  
AT (0.5 PSI)

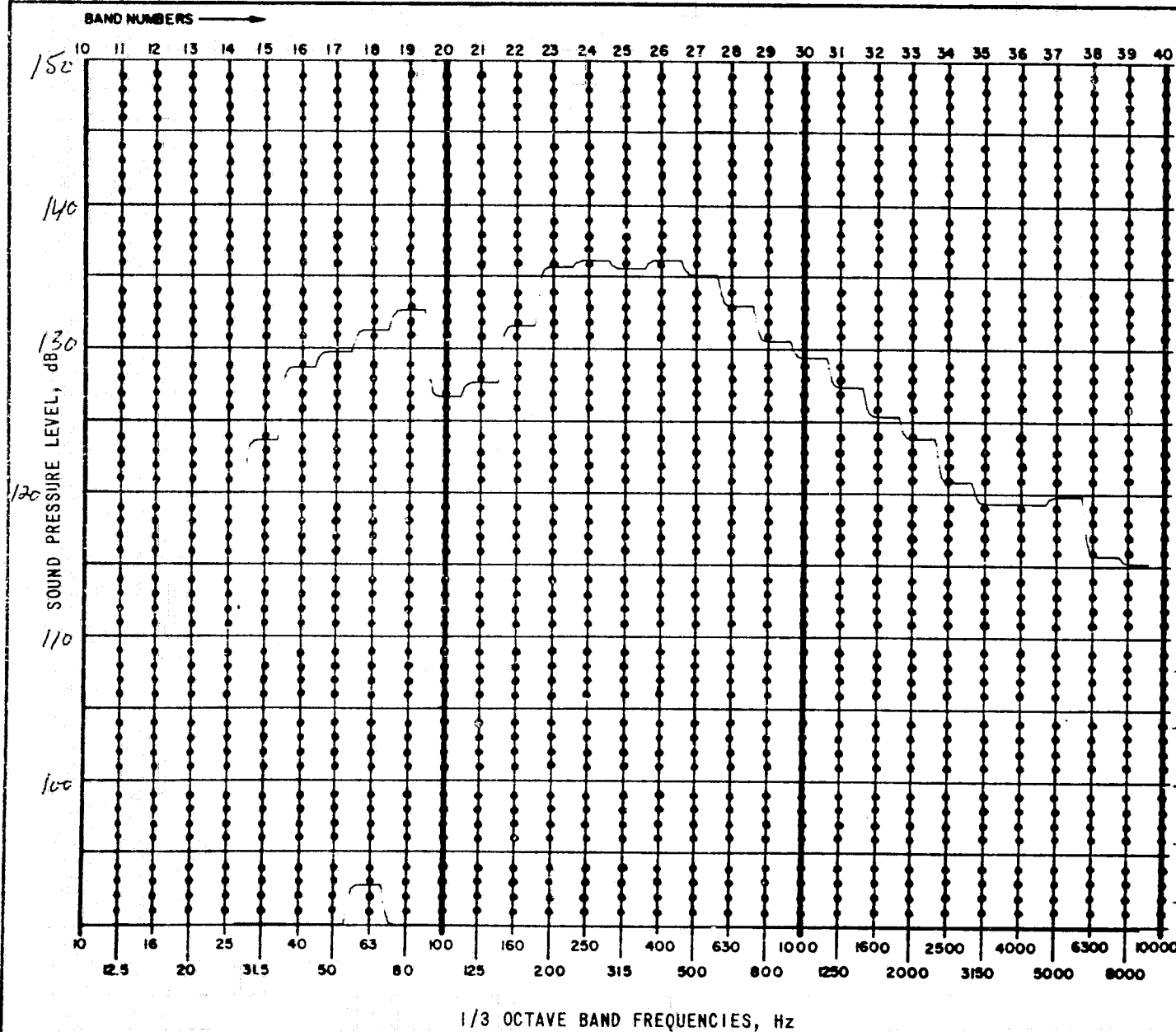
Plot # 29

EXTERNAL MICROPHONE

AVERAGE

A31

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 3

MICROPHONE NO. 1M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS AIR IN JACKET

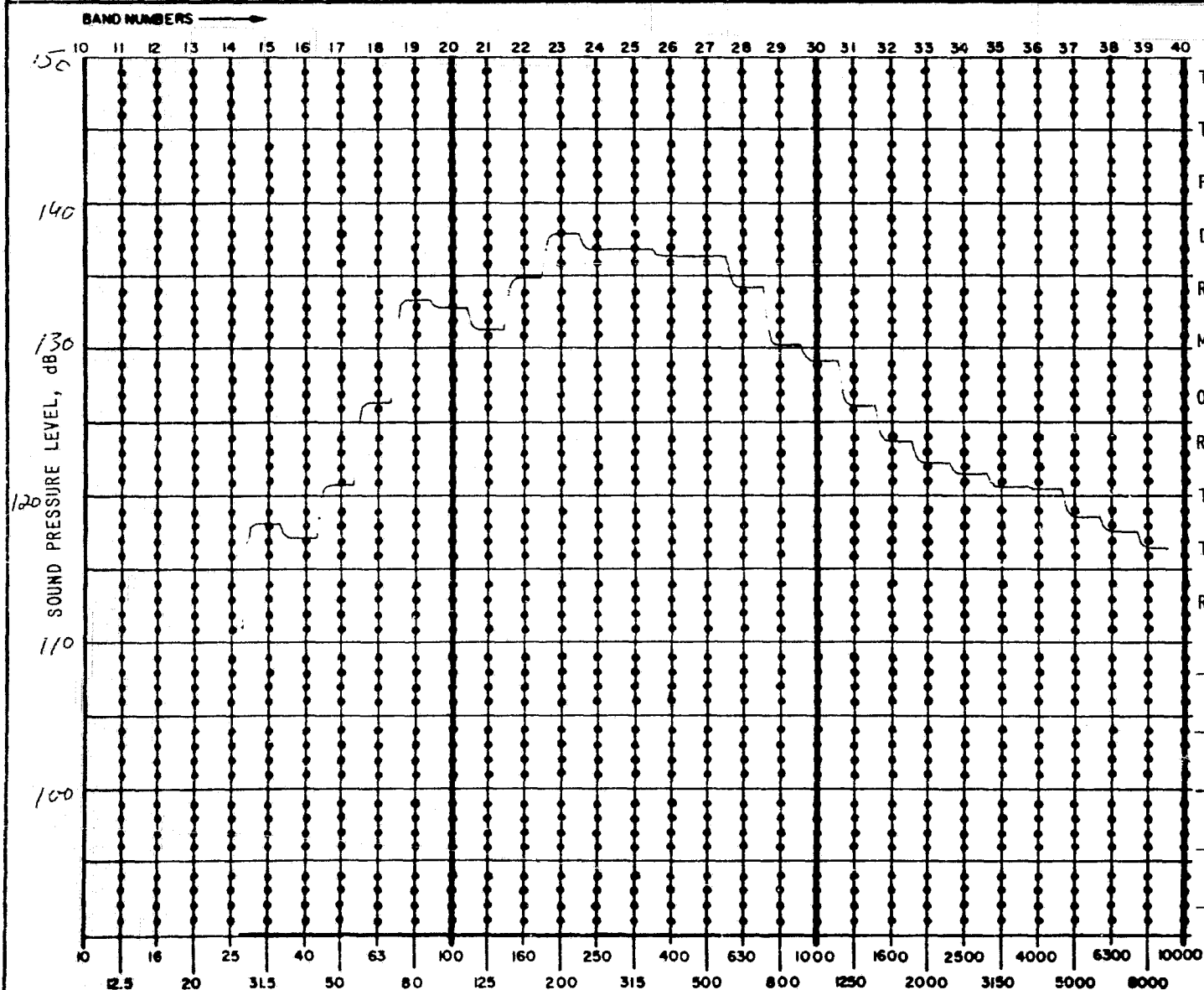
3448 N/M2  
AT ~ (0.5 PSI)

Plot # 30

EXTERNAL

A32

# ACOUSTIC DATA SHEET



TEST ITEM Comp. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 7-15-76

RUN NO. 4

MICROPHONE NO. 2M (145)

OVERALL LEVEL 145 CN ± 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

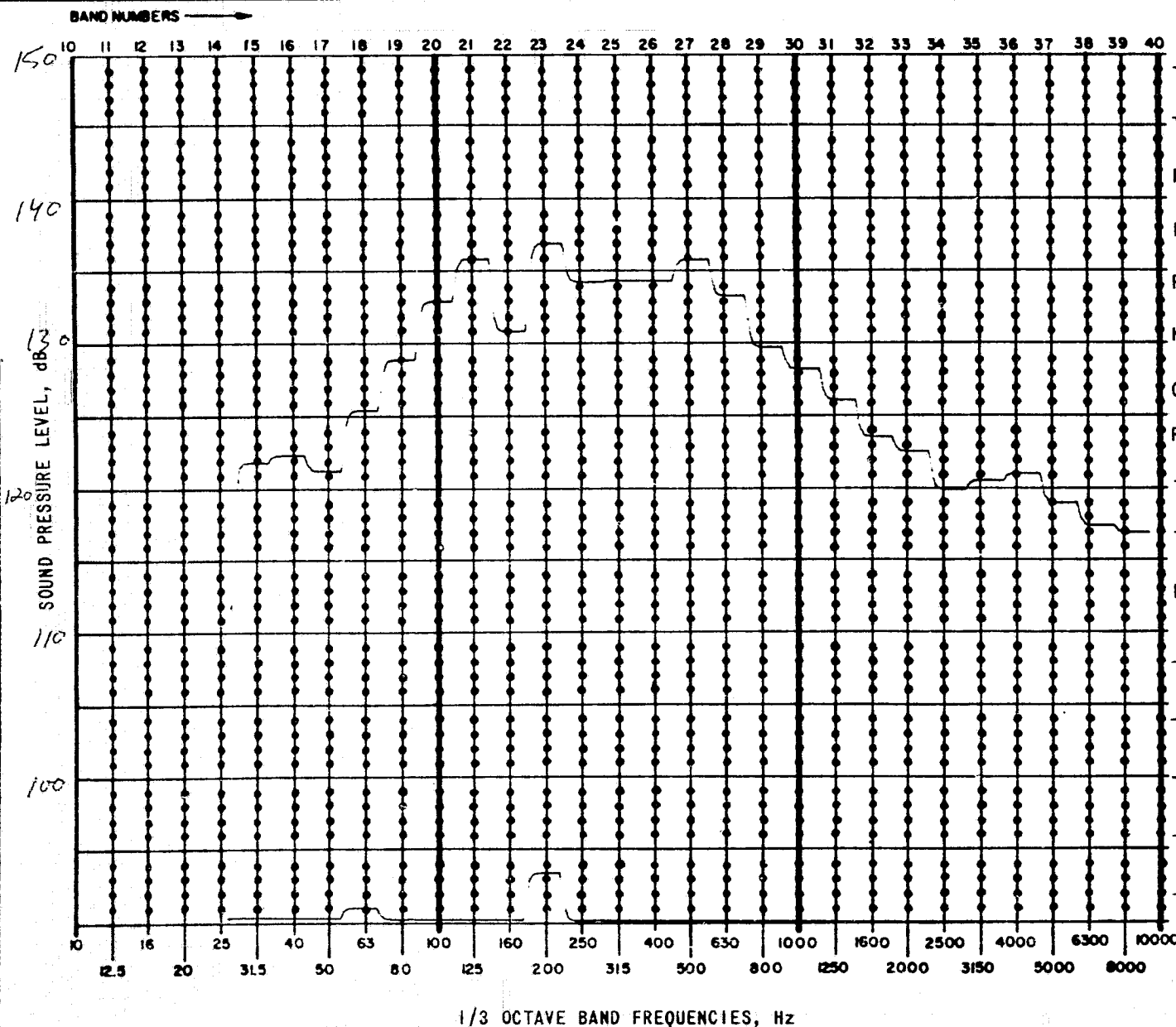
REMARKS 3448 N/M<sup>2</sup>  
(0.5 PSI) AIR

Plot # 31

EXTERNAL

A33

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 5

MICROPHONE NO. 3M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

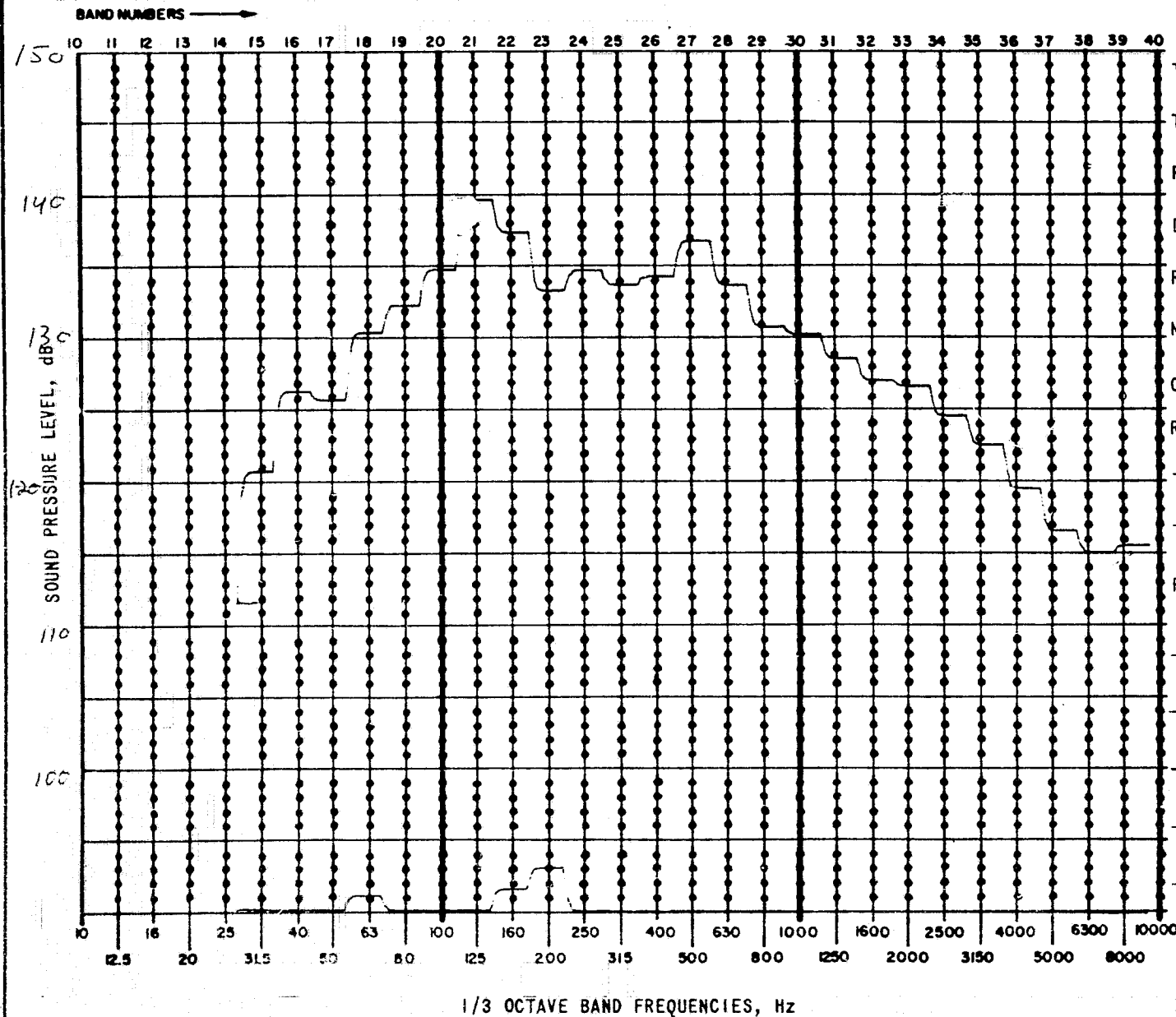
REMARKS 3448. N/m<sup>2</sup>  
~(0.5 PSI) AIR

Plot # 32

EXTERNAL

A34

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 6

MICROPHONE NO. 4M

OVERALL LEVEL 145.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

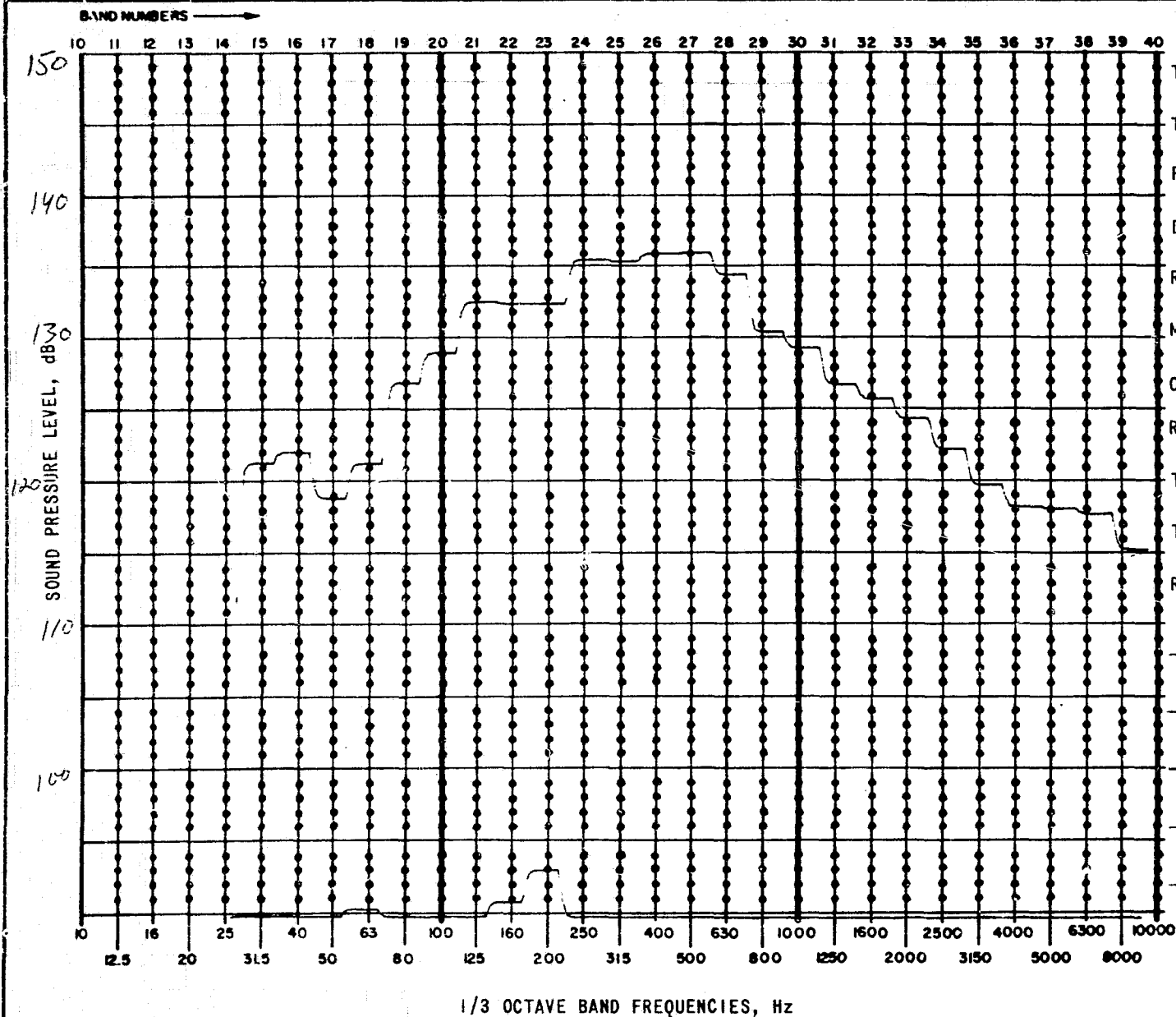
TEST TECHNICIAN ROBERSON

REMARKS 3448 N/M<sup>2</sup>  
(0.5 PSI) AIR

Plot # 33

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 7

MICROPHONE NO. 5M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

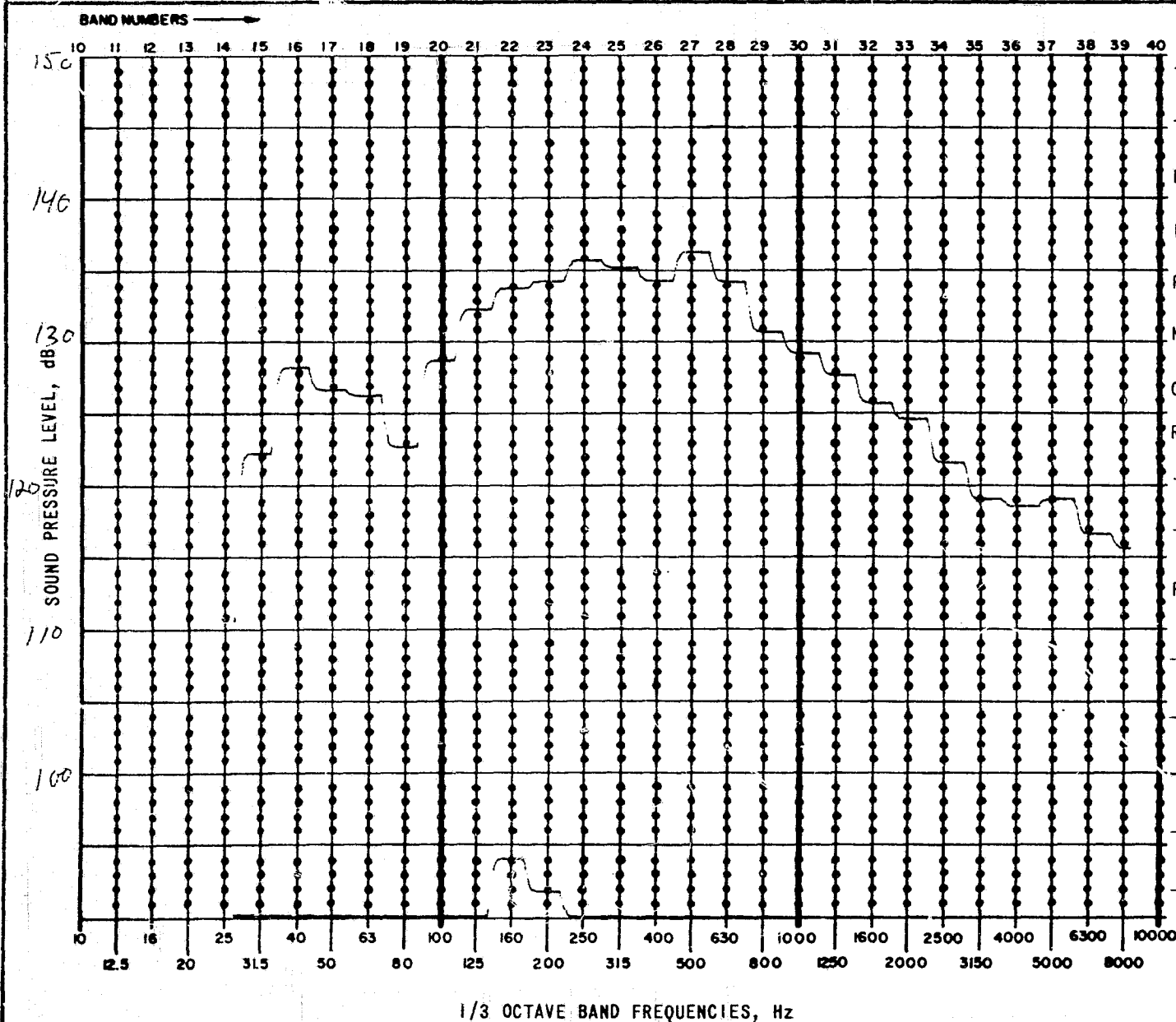
TEST TECHNICIAN ROBERTSON

REMARKS 3448 N/M<sup>2</sup>  
(0.5 PSI) AIR

Plot # 34

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST FLAL

PROGRAM SS

DATE 7-15-76

RUN NO. 8

MICROPHONE NO. 6M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

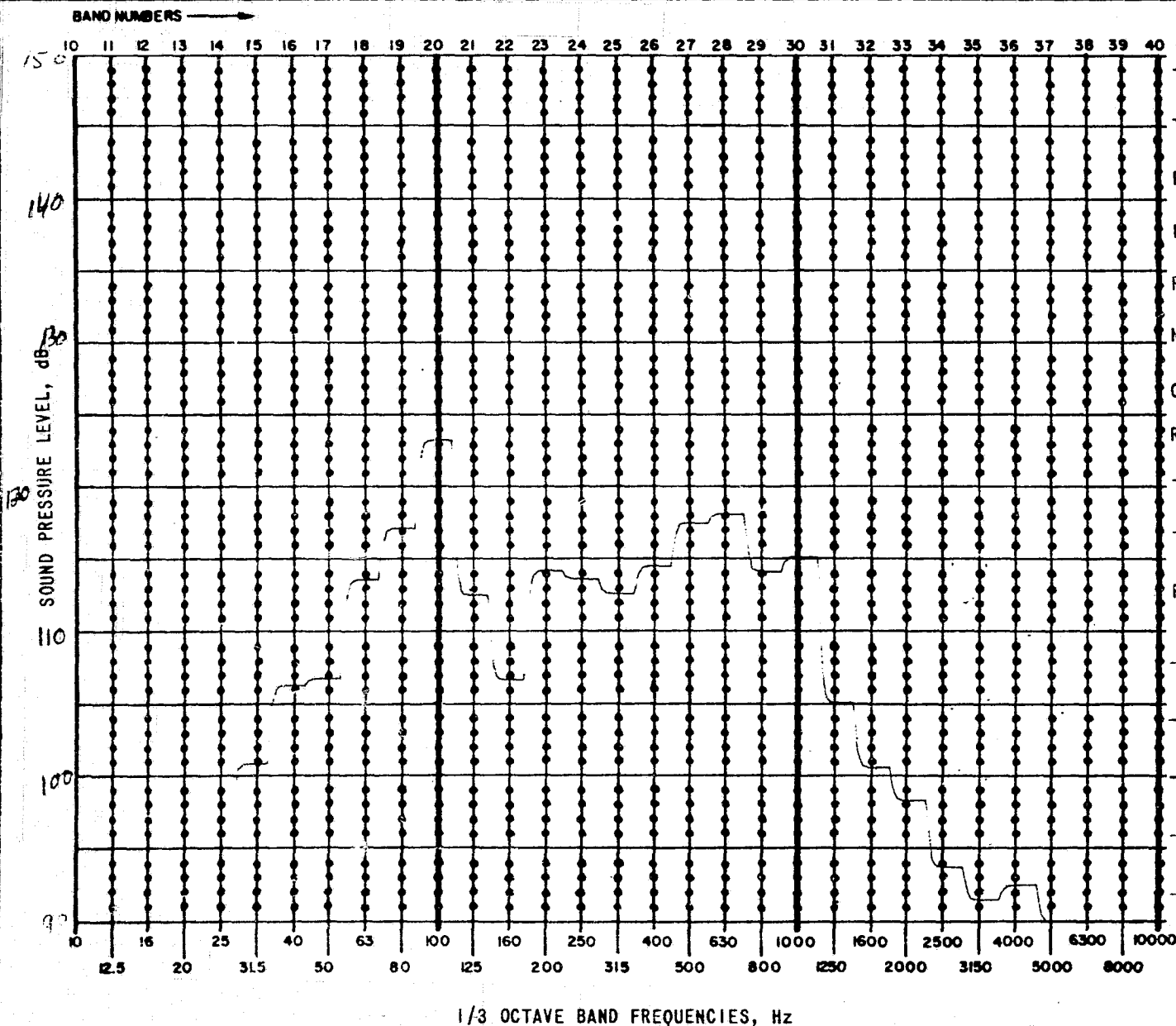
REMARKS 3448. N/M<sup>2</sup>  
(0.5 PSI) AIR

Plot No. 35

EXTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 2

MICROPHONE NO. 1-6 AUG

OVERALL LEVEL 145 ON 1M

RUN DURATION 10 SEC

TEST ENGINEER 3N4DER

TEST TECHNICIAN KOBERSON

REMARKS AIR IN JACKET

3448 N/M<sup>2</sup>

AT (0.5 PSI)

Plot # 36

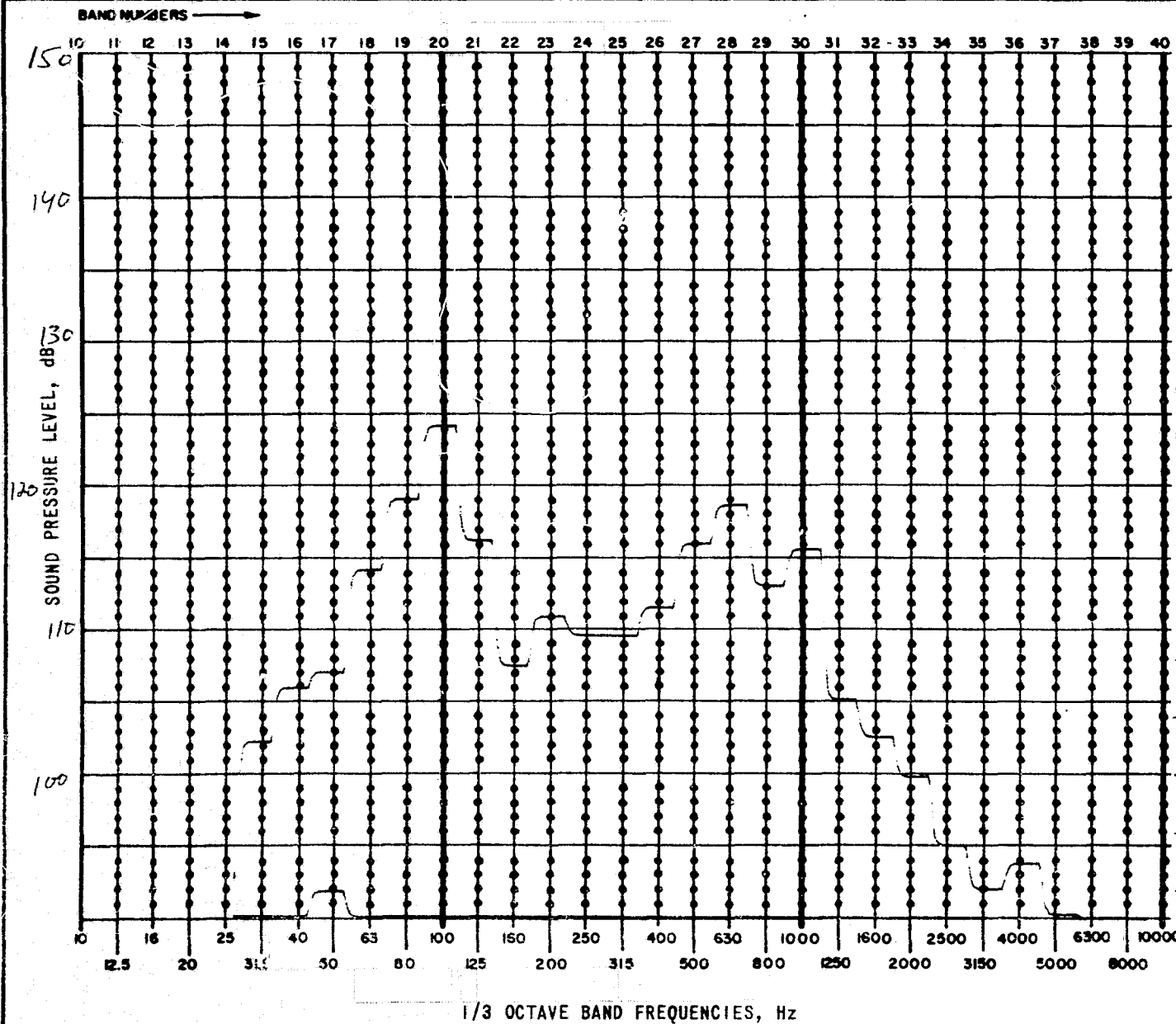
INTERNAL MICROPHONE

AVERAGE

A38

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 9

MICROPHONE NO. 1

OVERALL LEVEL 127

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBINSON

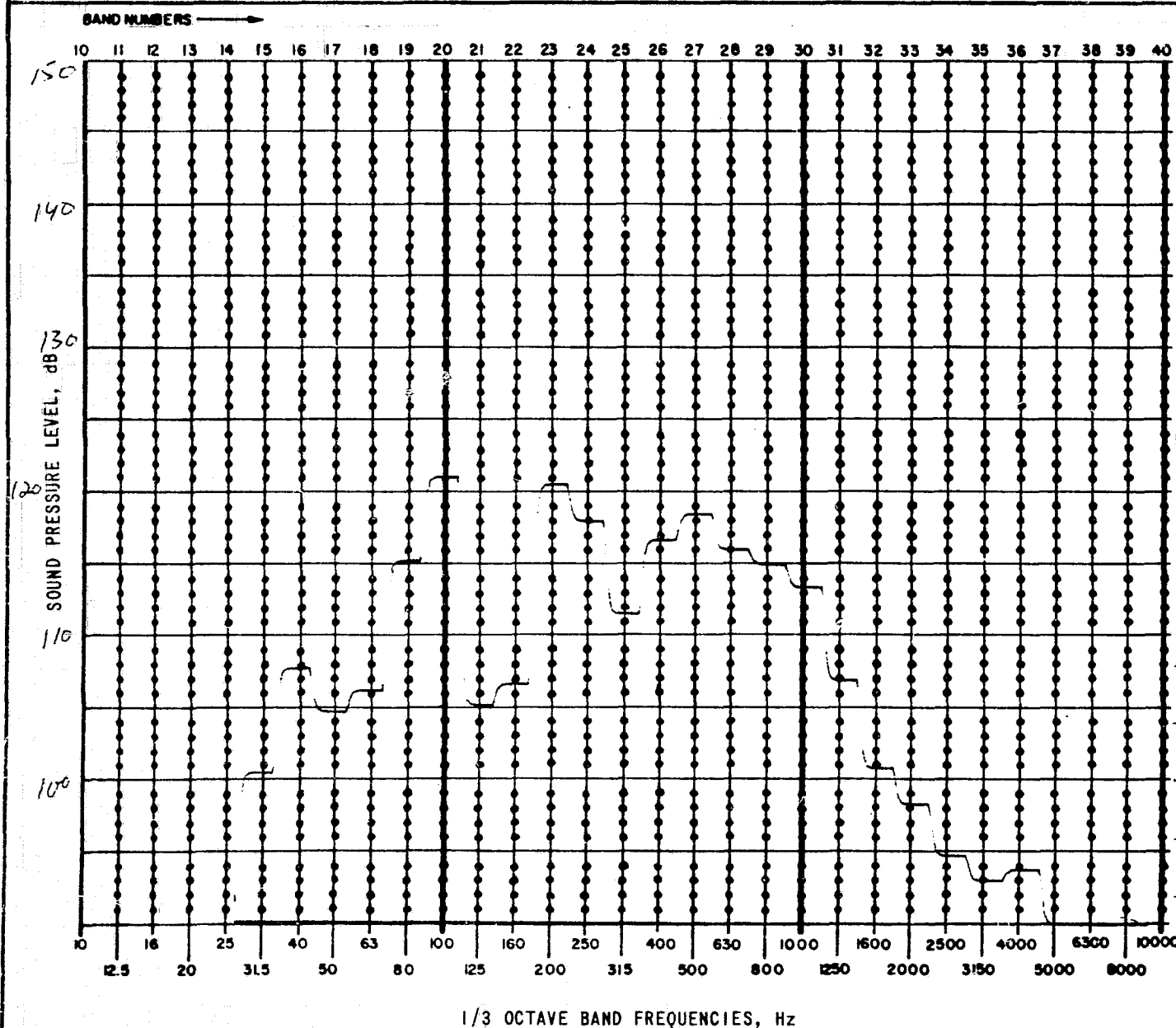
REMARKS 3448 N/M<sup>2</sup>  
(C, 5 PSI) AIR

Plot # 37

INTERNAL

A39

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 10

MICROPHONE NO. 2

OVERALL LEVEL 126.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

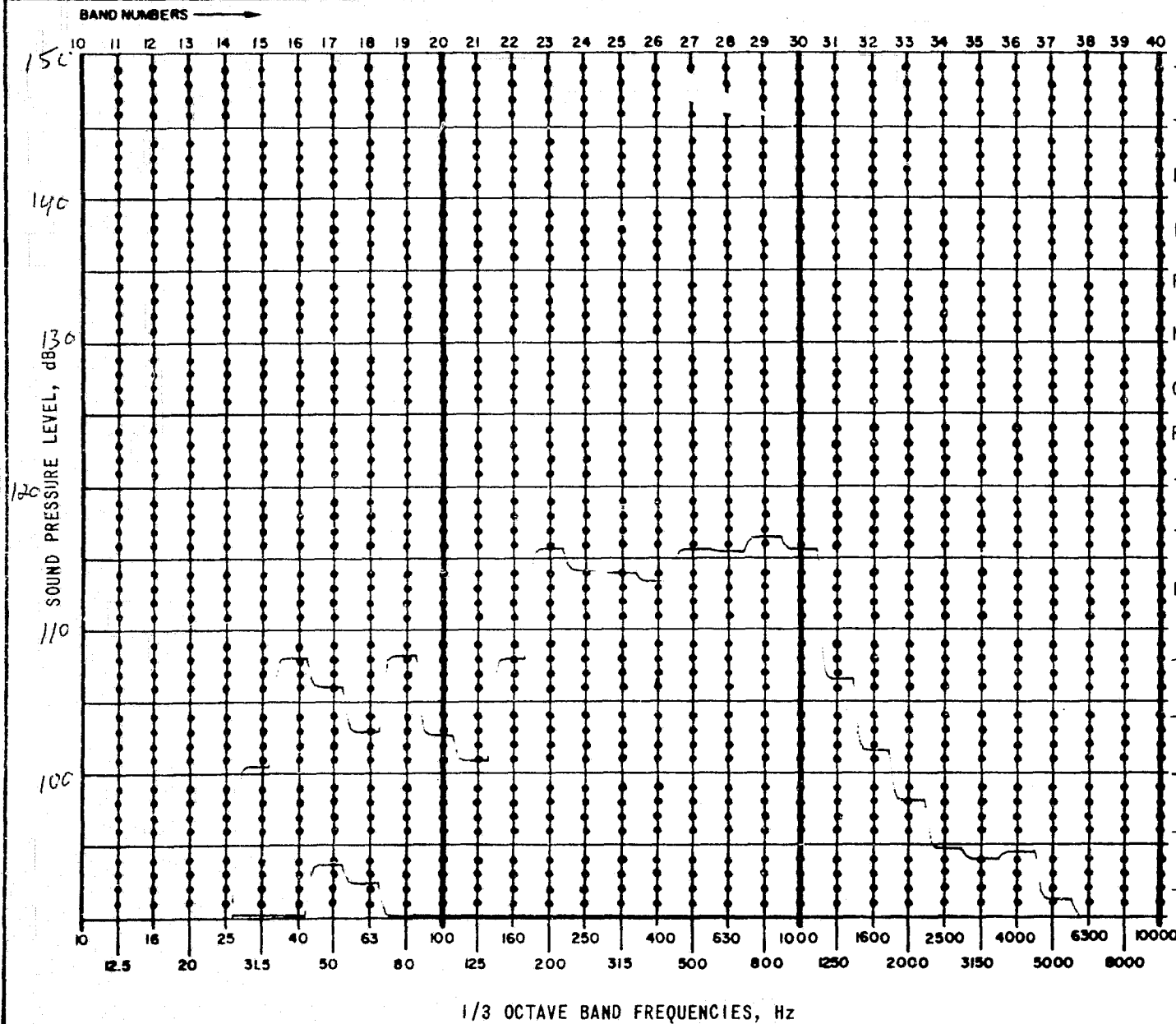
REMARKS 3448. N/M<sup>2</sup>  
(0.5 PSI) AIR

Plot # 38

INTERNAL

AAO

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 11

MICROPHONE NO. 3

OVERALL LEVEL 125

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

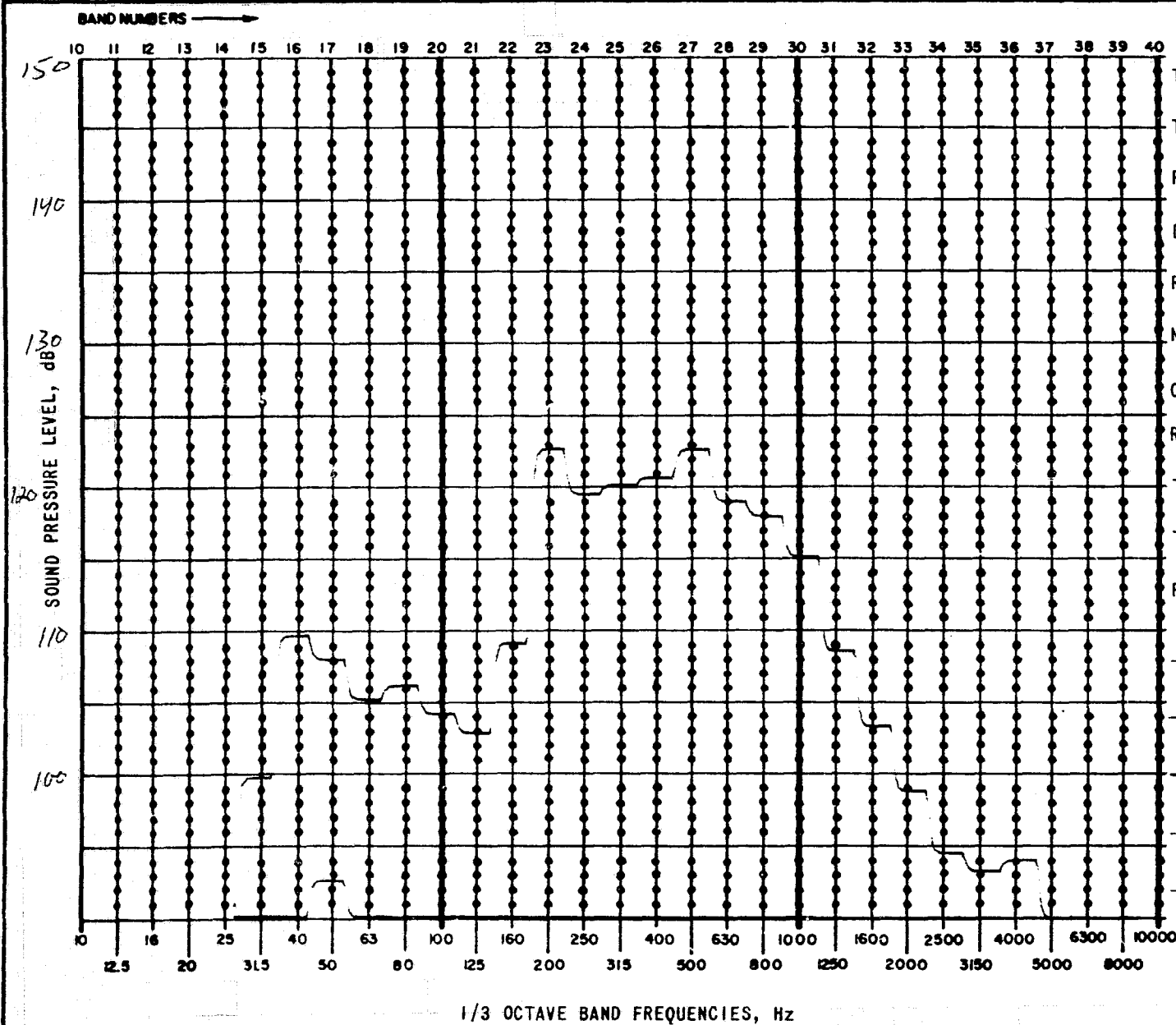
REMARKS 3448 N/AZ  
C.S. PSI) AIR

Plot # 39

INTERNAL

A4.1

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 12

MICROPHONE NO. 4

OVERALL LEVEL 128

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

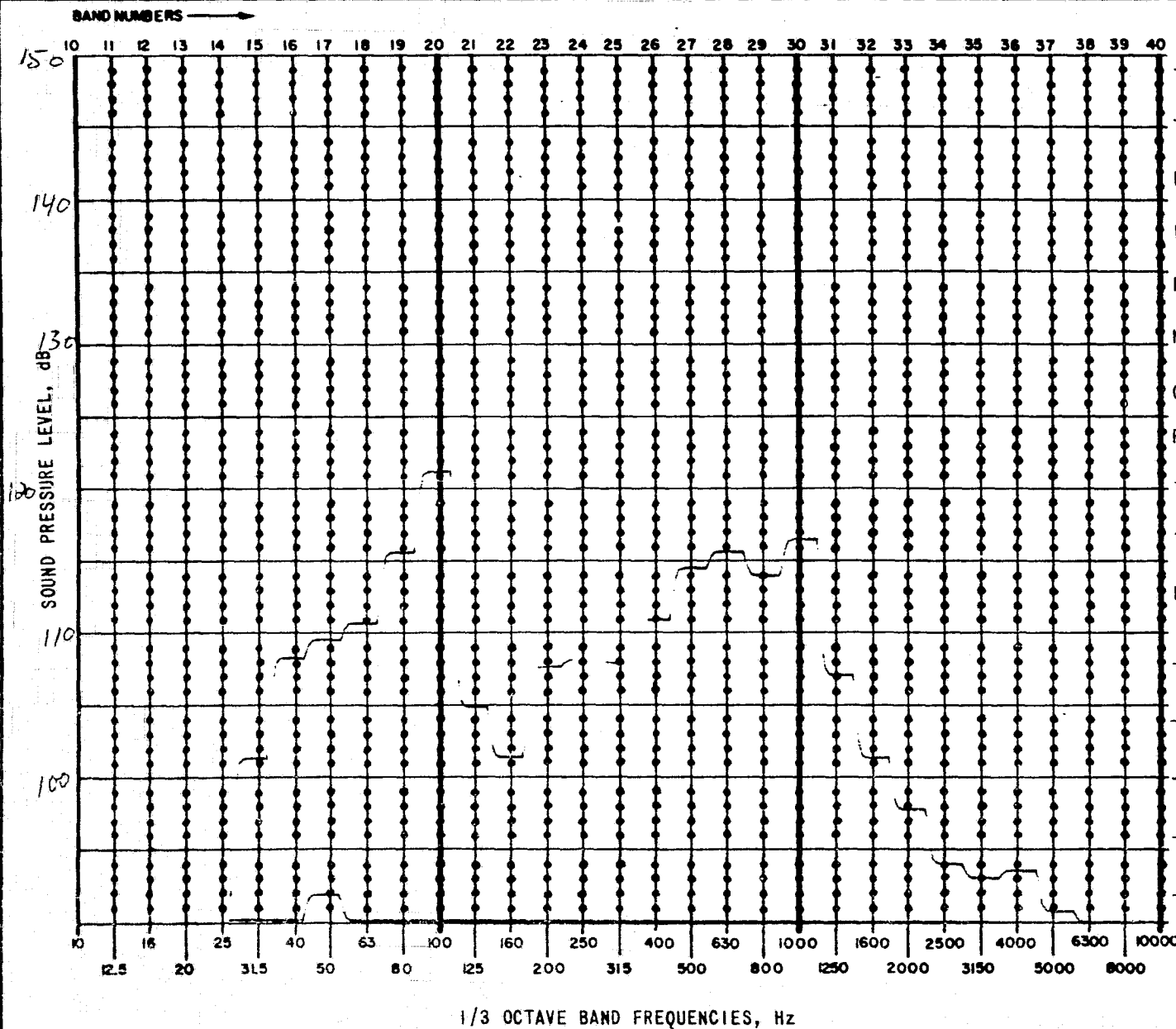
REMARKS 3448. N/AIR

(0.5 PSI) AIR

Plot #40

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 13

MICROPHONE NO. 5

OVERALL LEVEL 124

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS 3448 N/M<sup>2</sup>  
~(0.5 PSI) AIR

Plot # 41

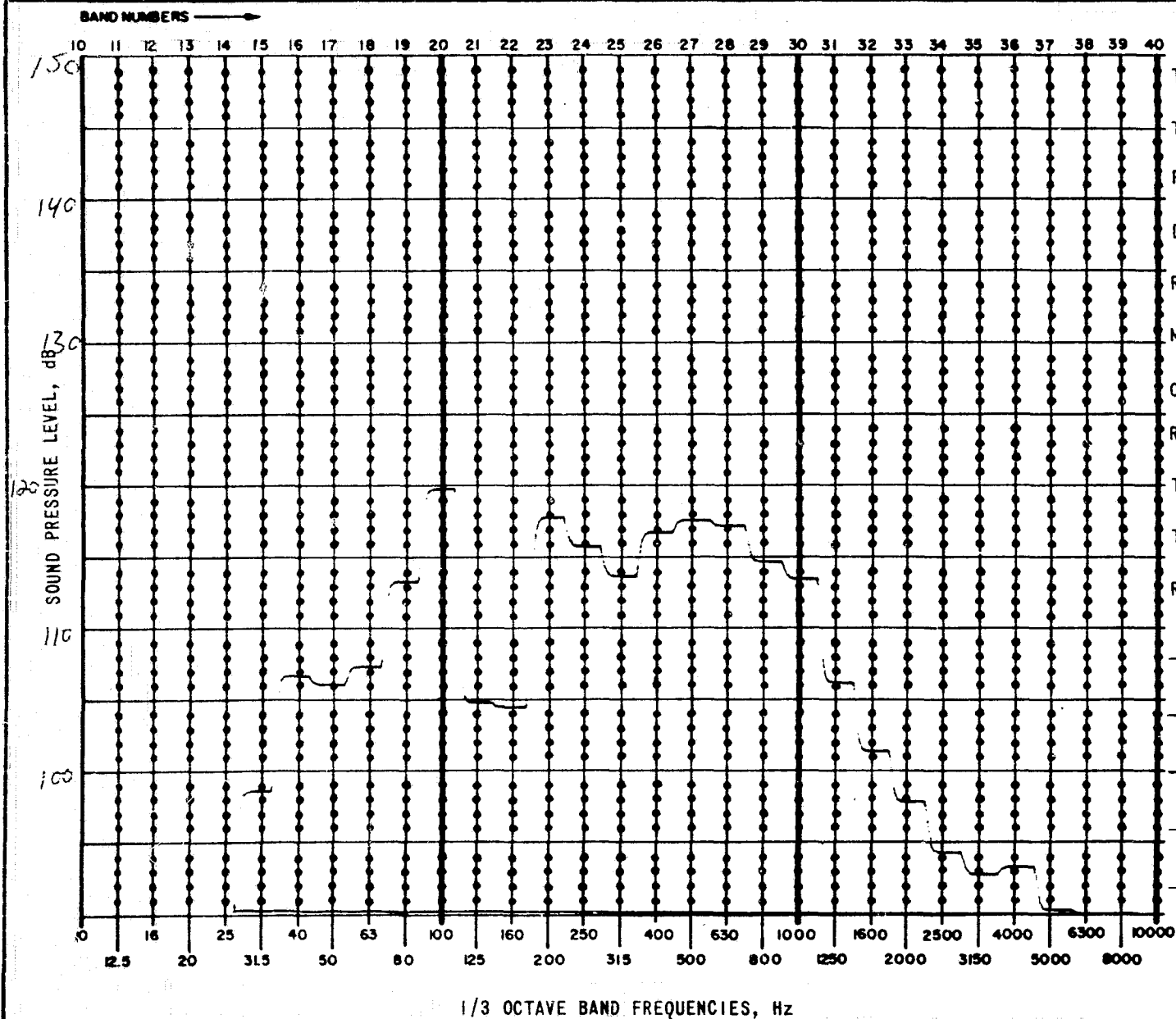
INTERNAL

A43

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR



# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 14

MICROPHONE NO. 6

OVERALL LEVEL 126

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

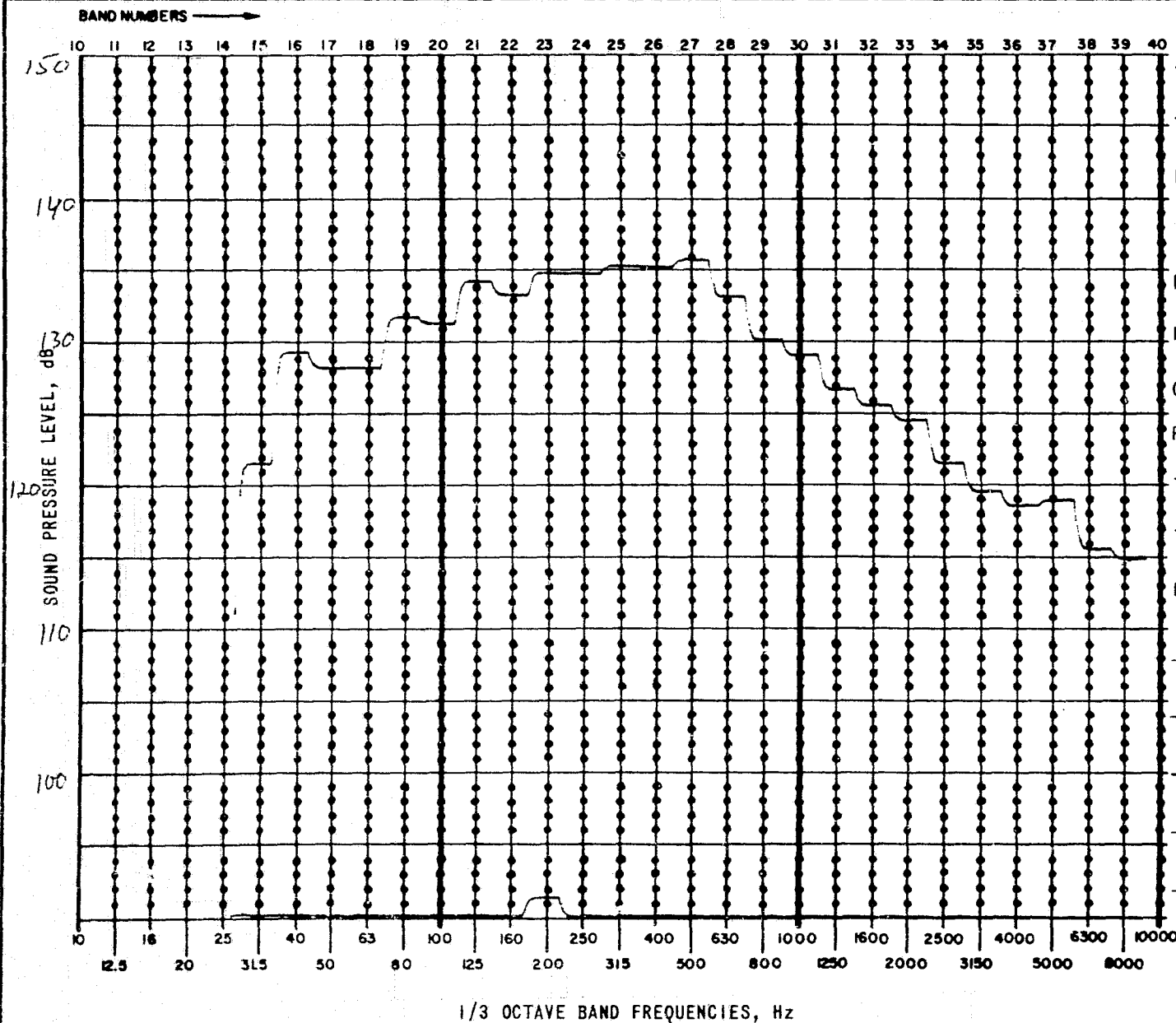
REMARKS 3448 N/M<sup>2</sup>  
~(0.5 PSI) AIR

Plot # 42

INTERNAL

A44

# ACOUSTIC DATA SHEET



TEST ITEM COMP SHROUD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 29

MICROPHONE NO. 1M-6MA6

OVERALL LEVEL 145 CN 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

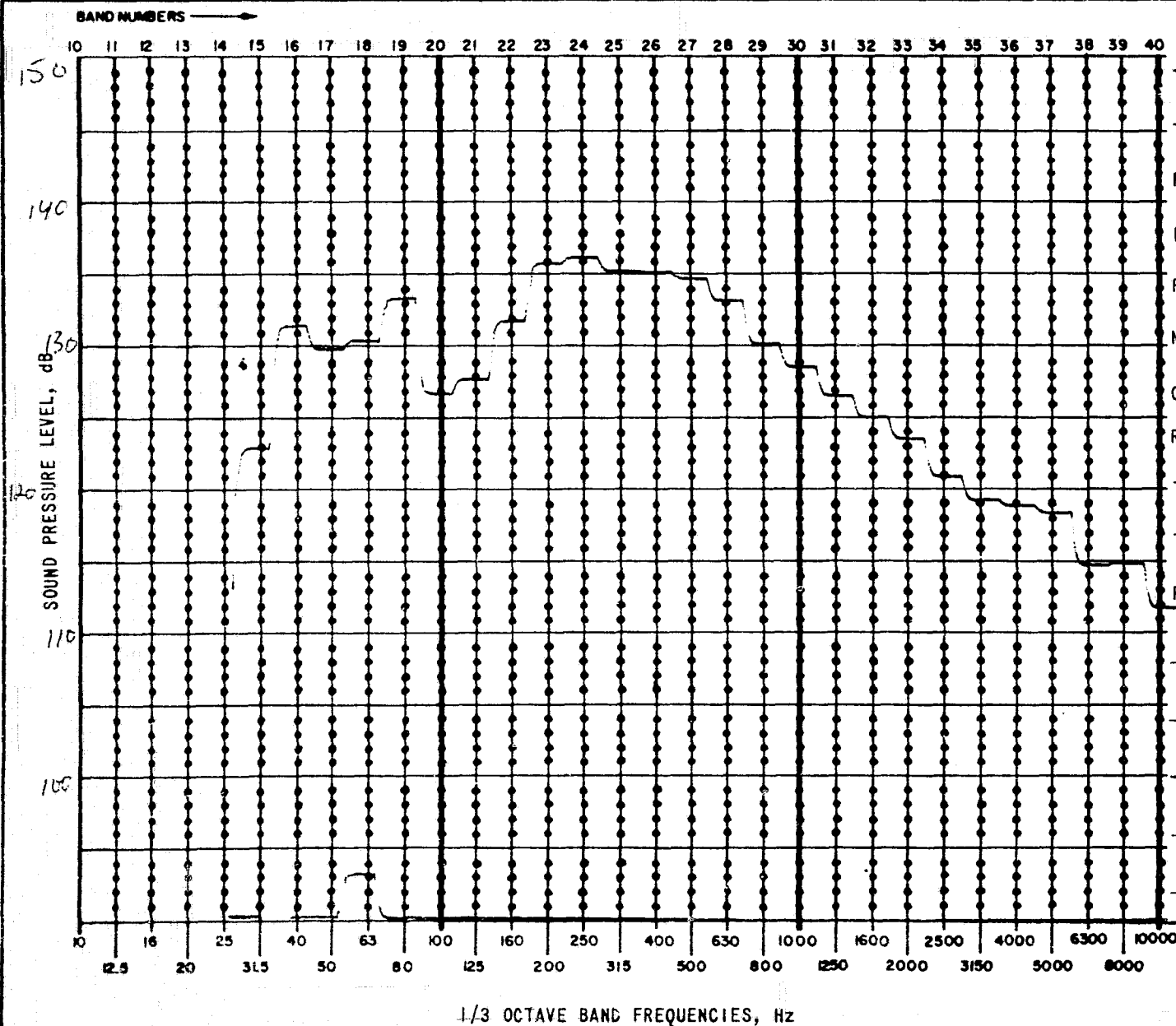
REMARKS 3448 12/1/72  
HELIUM (0.5PSI)

Plot # 43

EXTERNAL MICROPHONE

AVERAGE

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 37

MICROPHONE NO. 1M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

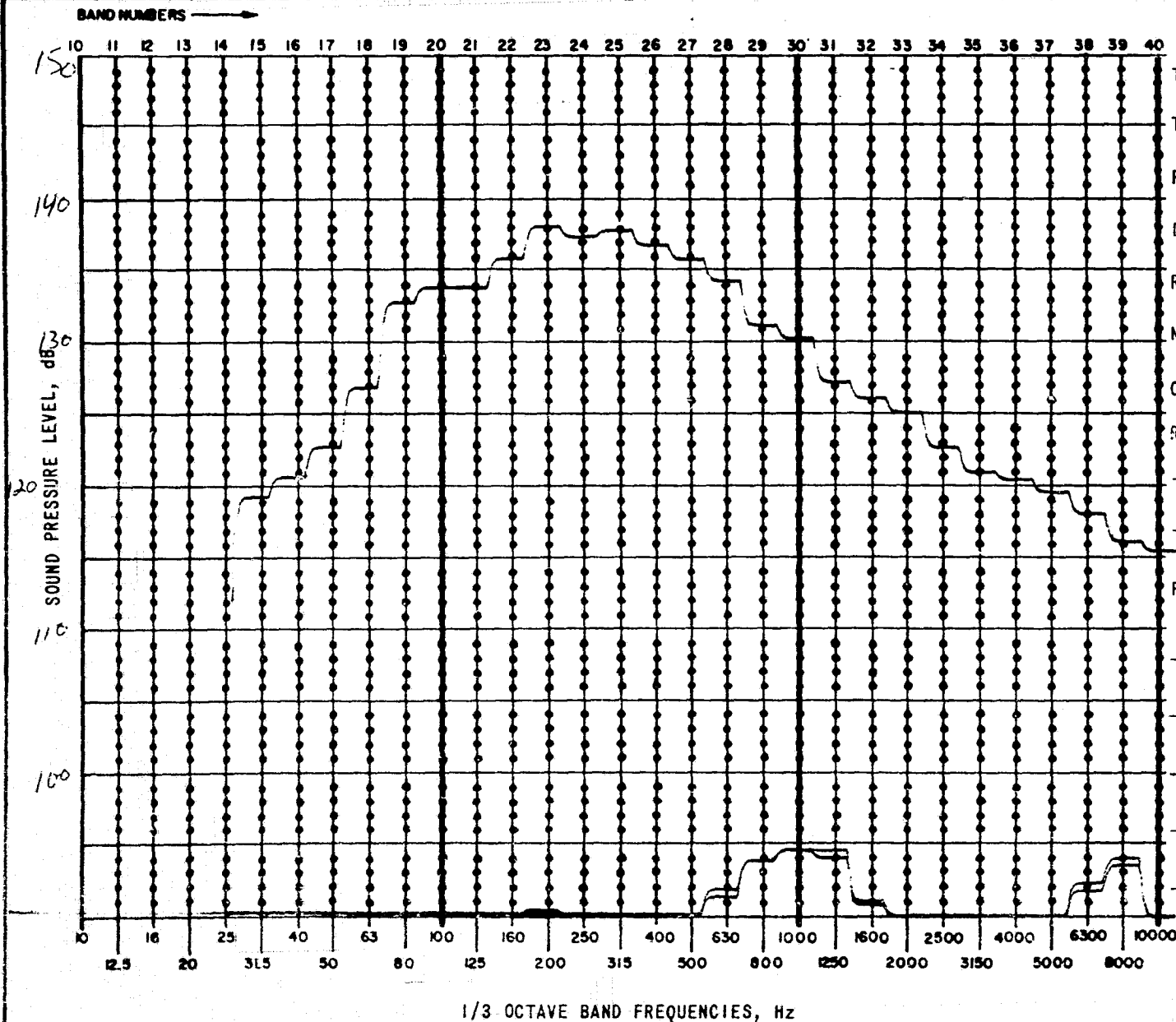
TEST TECHNICIAN ROBERSON

REMARKS 3448 N/M<sup>2</sup>  
(C. 5 PSI) HELIUM

Plot # 44

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST FLAC

PROGRAM SS

DATE 7-15-76

RUN NO. 38

MICROPHONE NO. 2M

OVERALL LEVEL 146

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN BERSON

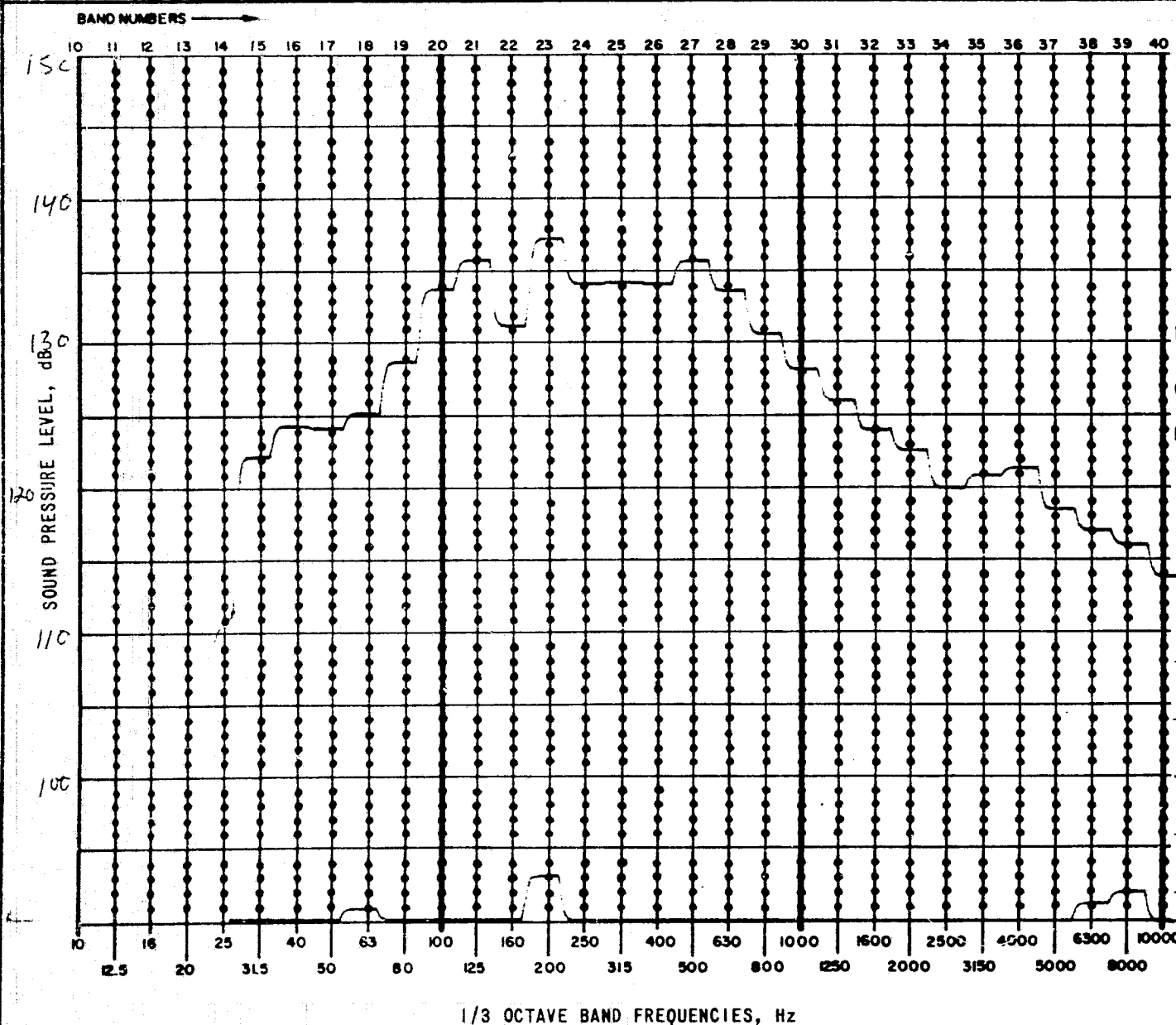
REMARKS 3448 N/A<sup>2</sup>  
(C.5 PSI) HELIUM

Plot # 45

EXTERNAL

A47

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 39

MICROPHONE NO. 3M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

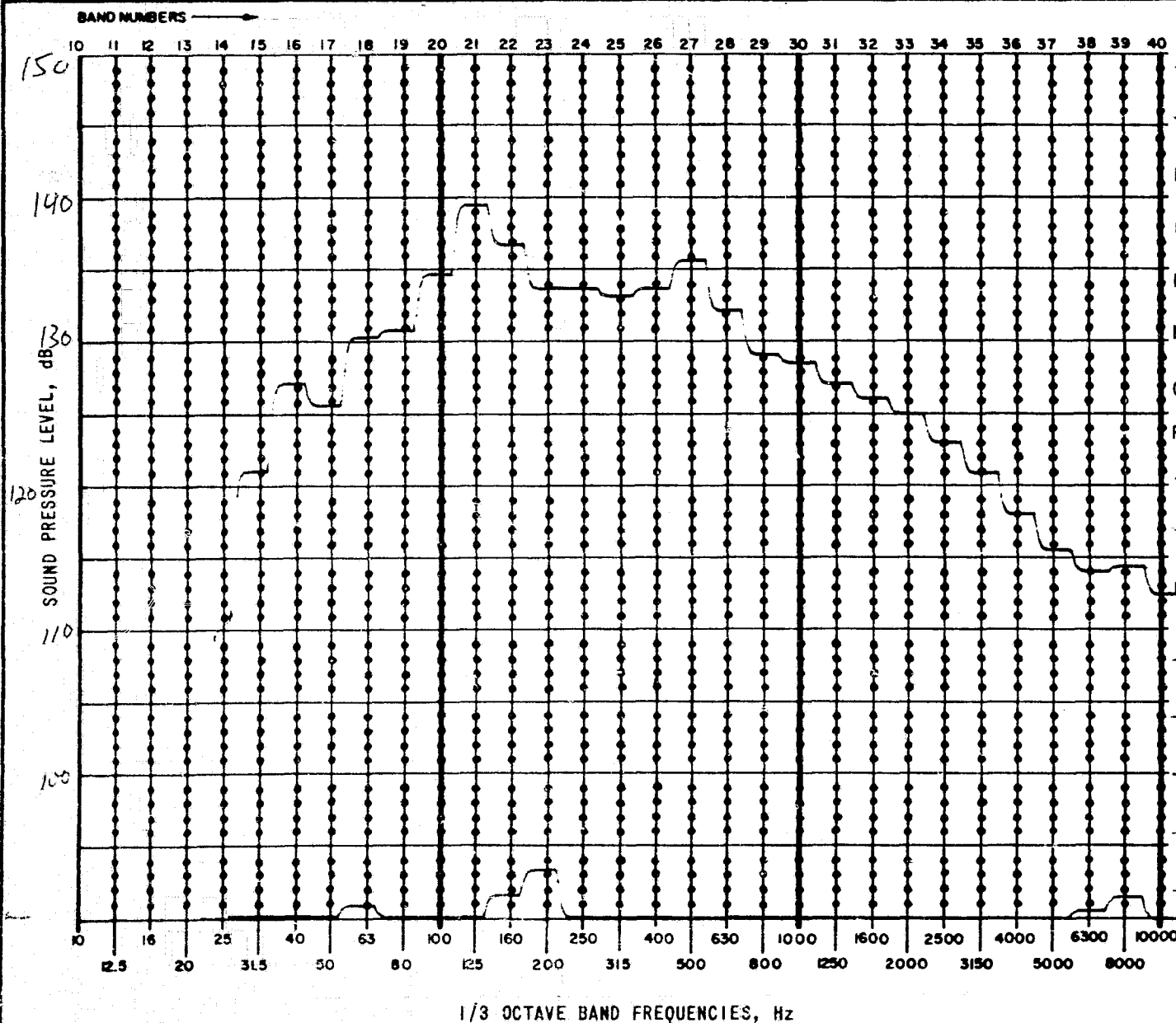
TEST TECHNICIAN ROBERSON

REMARKS 3448 N/A<sup>2</sup>  
(0.5 PSI) HELIUM

Plot #46

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHIELD

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 40

MICROPHONE NO. 4M

OVERALL LEVEL 145.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

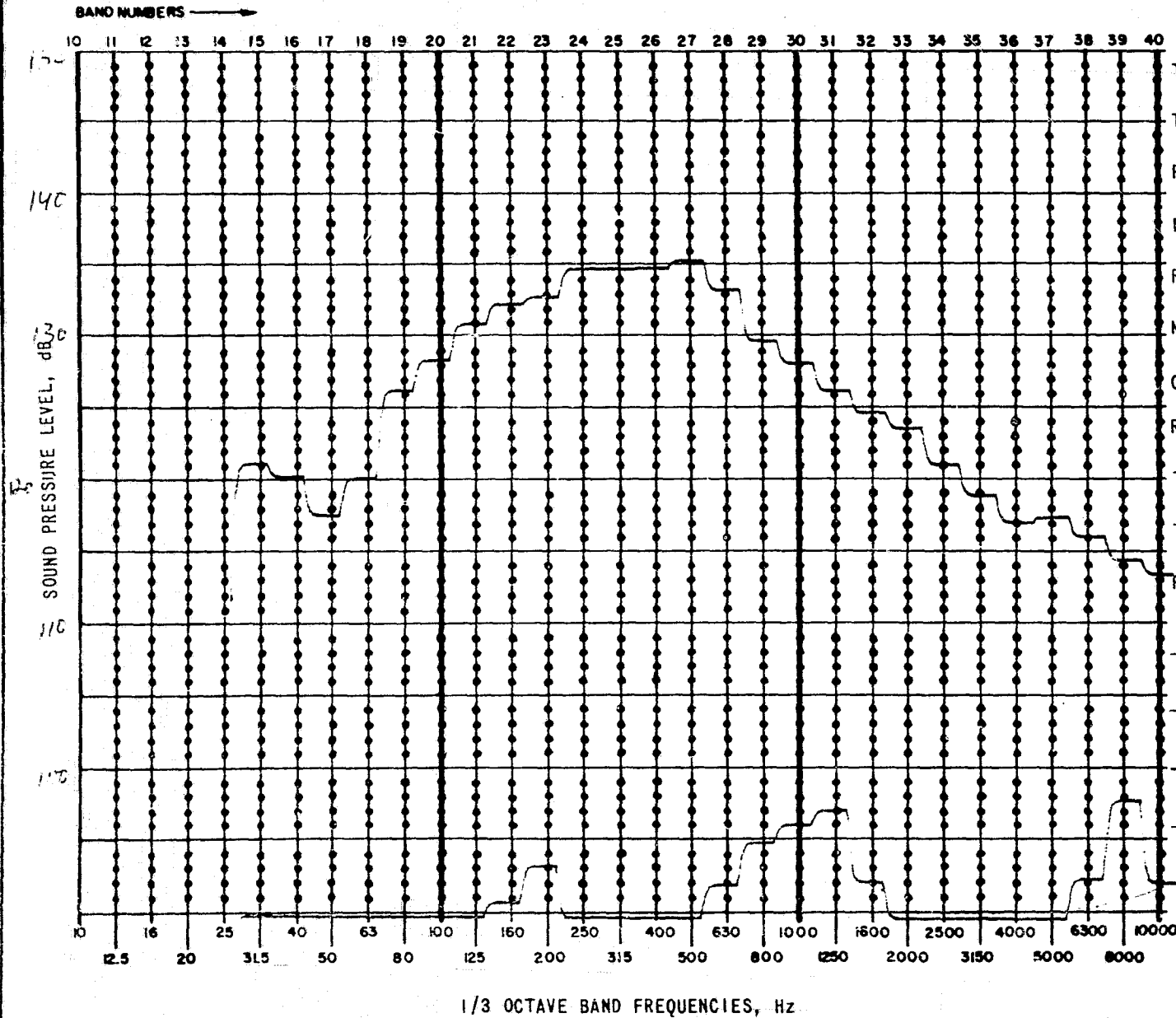
REMARKS 3448N/M<sup>2</sup>  
(C.5 PSI) HELIUM

Plot #47

EXTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 41

MICROPHONE NO. SM

OVERALL LEVEL \_\_\_\_\_

RUN DURATION 10SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

(3448 NIM<sup>2</sup>)

REMARKS 0.5 PSI HELIUM

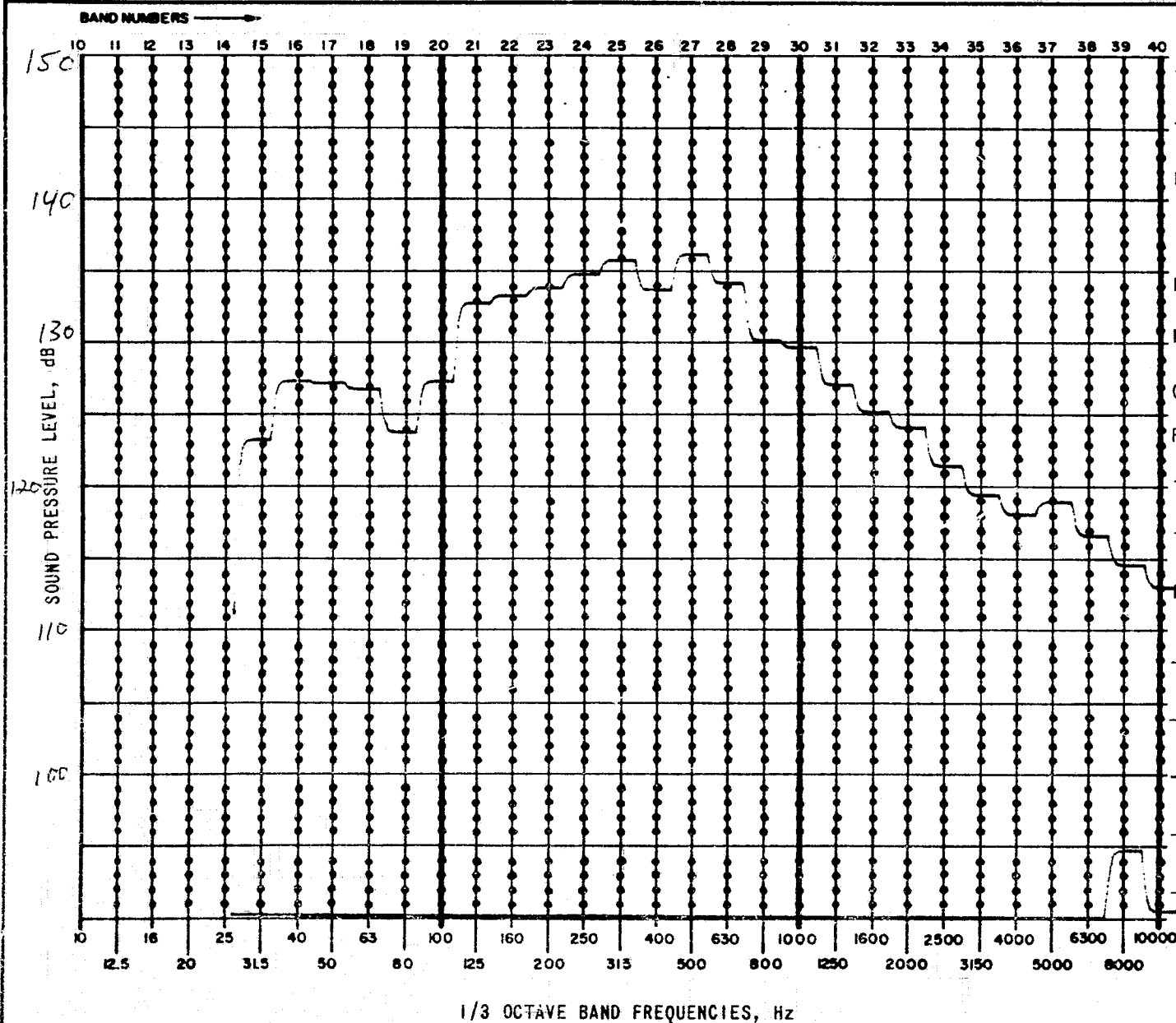
Plot # 48

EXTERNAL

A50

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 42

MICROPHONE NO. 6M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

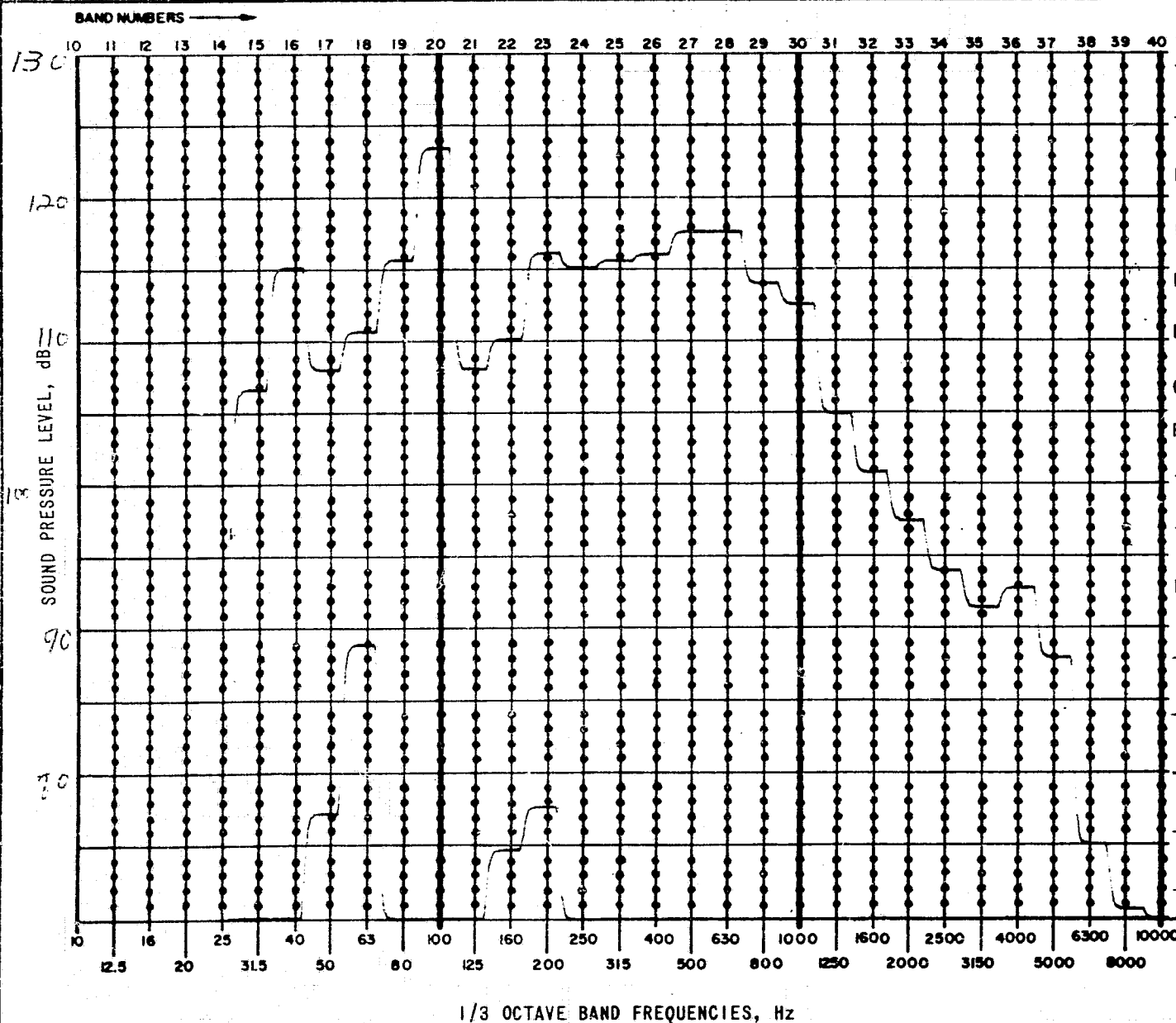
TEST TECHNICIAN ROBERSON

REMARKS 3448 N/m<sup>2</sup>  
(0.5 PSI) (HELIUM)

Plot # 49

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 30

MICROPHONE NO. 1-6 AUG

OVERALL LEVEL 145 ON 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

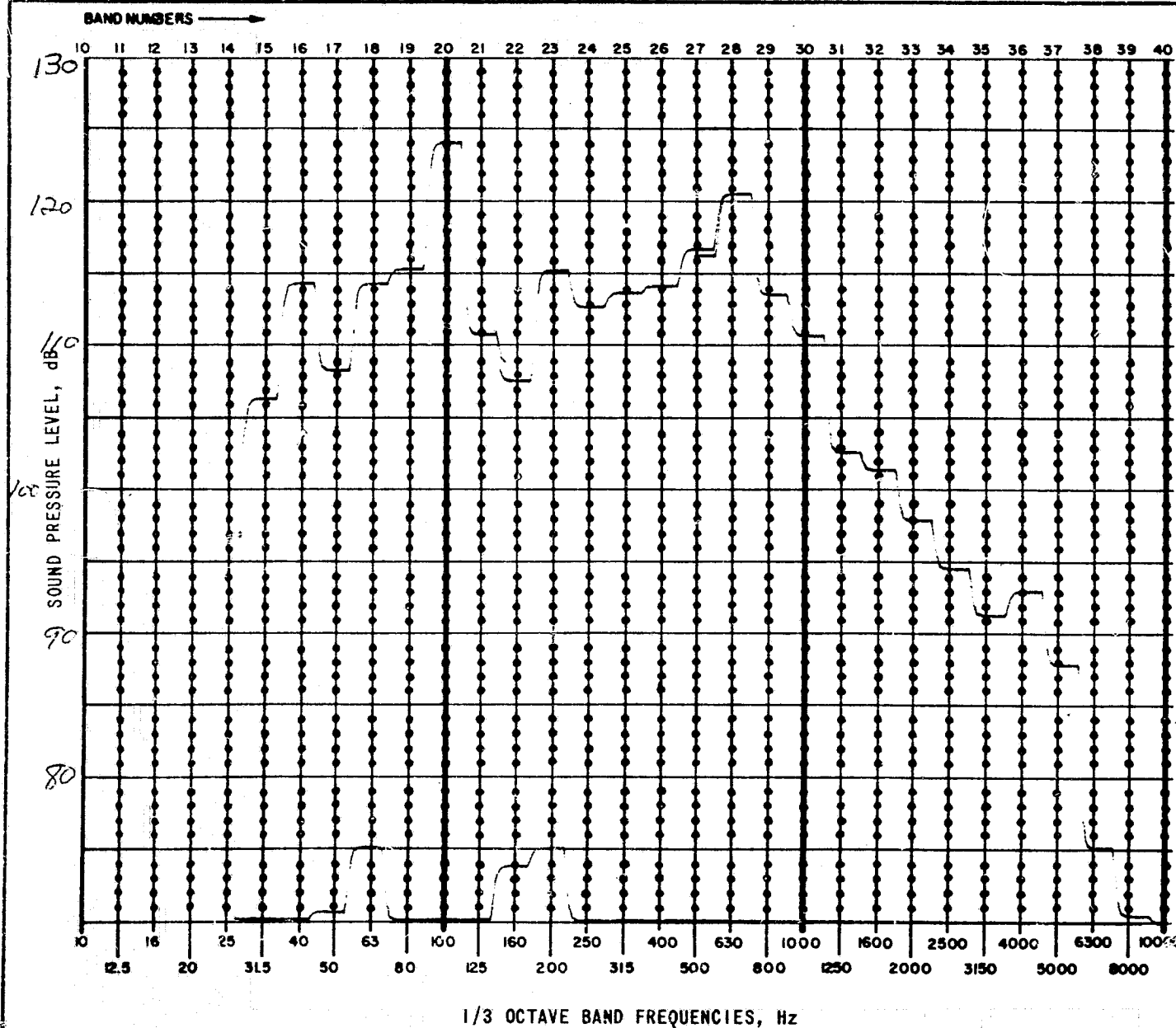
REMARKS 3448 N/m<sup>2</sup>  
(0.5 PSI) HELIUM

Plot # 50

INTERNAL MICROPHONE

AVERAGE

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 31

MICROPHONE NO. 1

OVERALL LEVEL 127

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

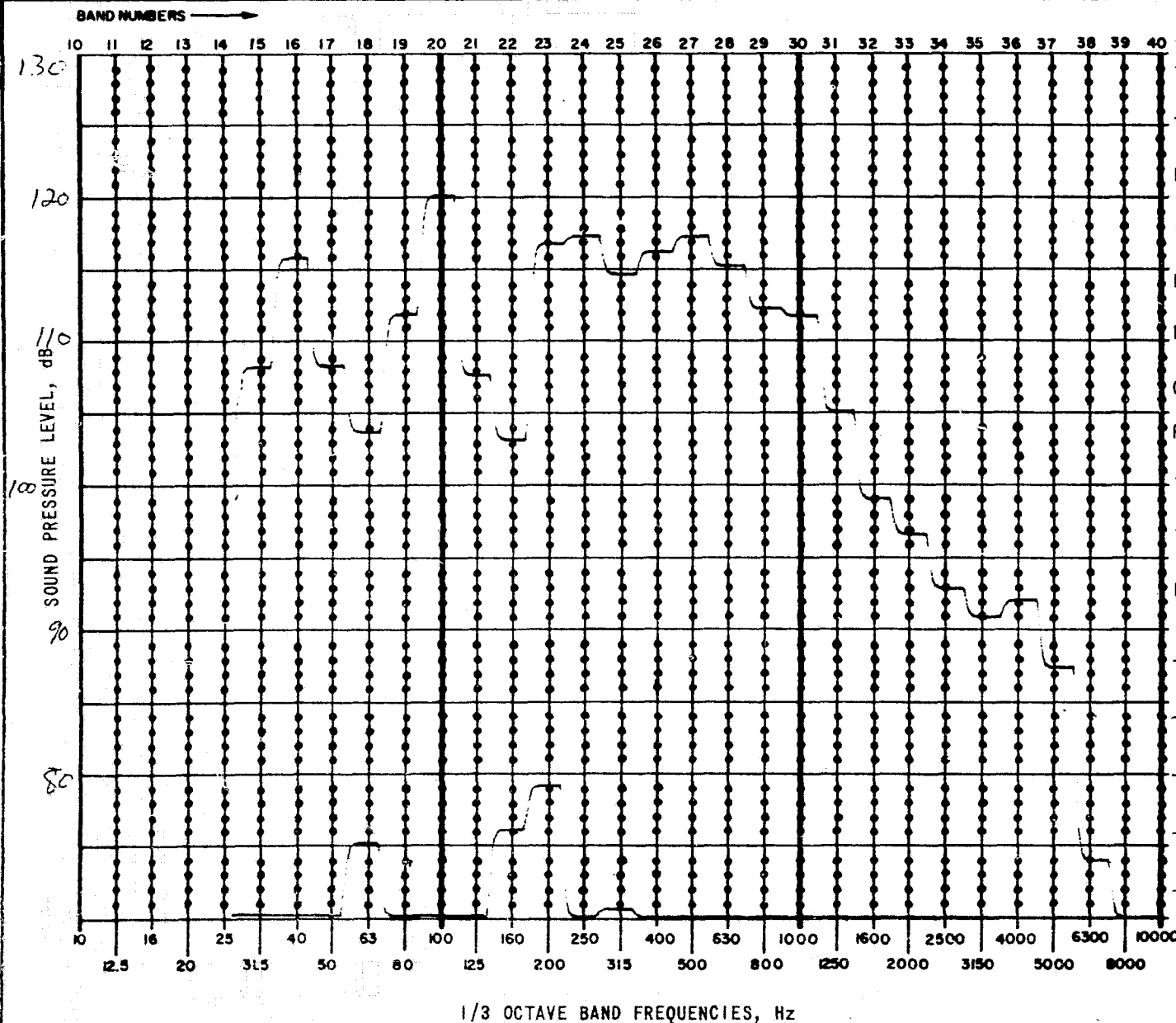
TEST TECHNICIAN ROBERSON

REMARKS 3448. NIM<sup>2</sup>  
(0.5 PSI) HELIUM

Plot # 51

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHROUD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 32

MICROPHONE NO. 2

OVERALL LEVEL 126

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

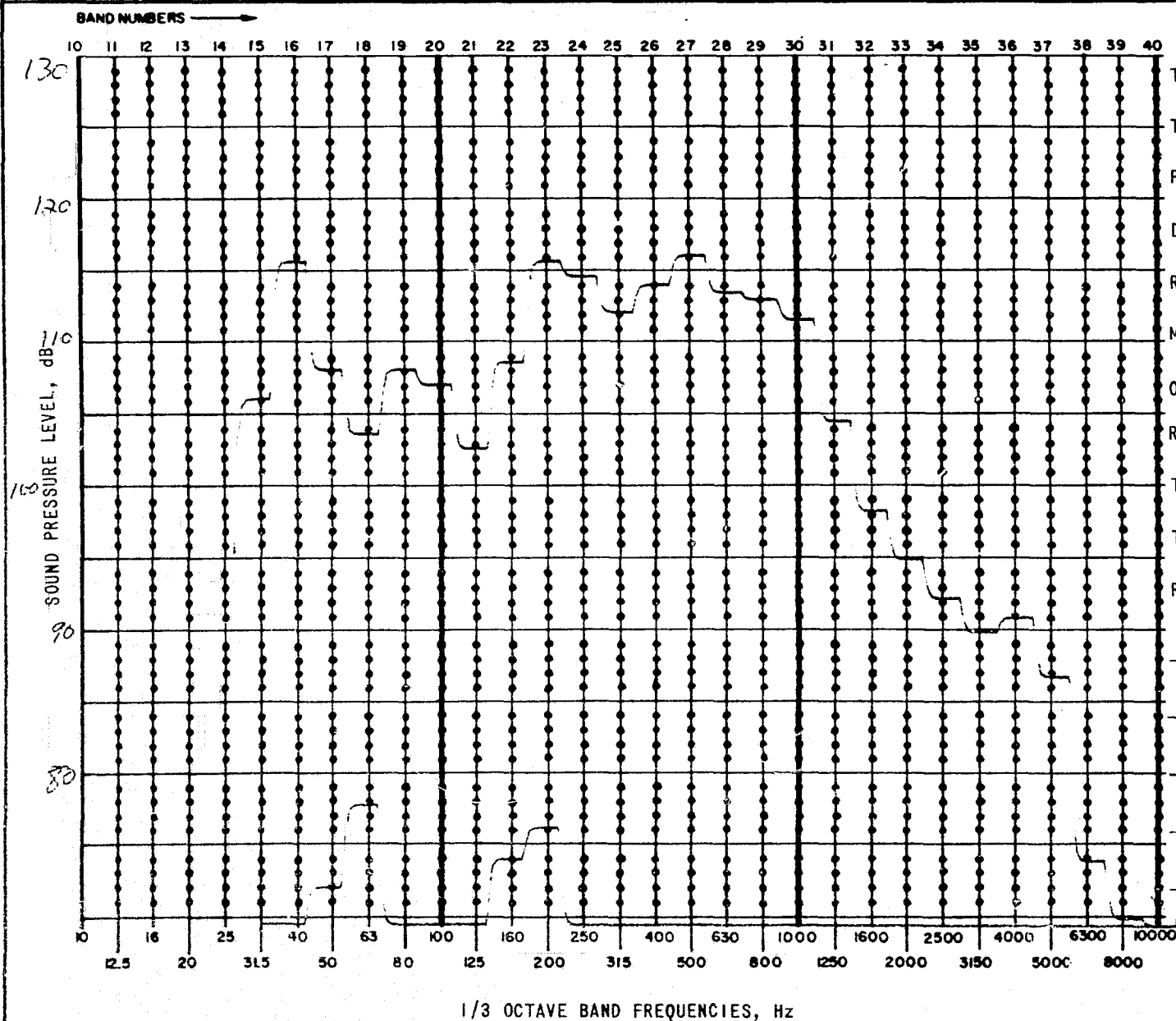
REMARKS 3448. N/M<sup>2</sup>  
(0.5 PSI) HELIUM

Plot #52

INTERNAL

AS4

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 7-15-76

RUN NO. 33

MICROPHONE NO. 3

OVERALL LEVEL 124

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

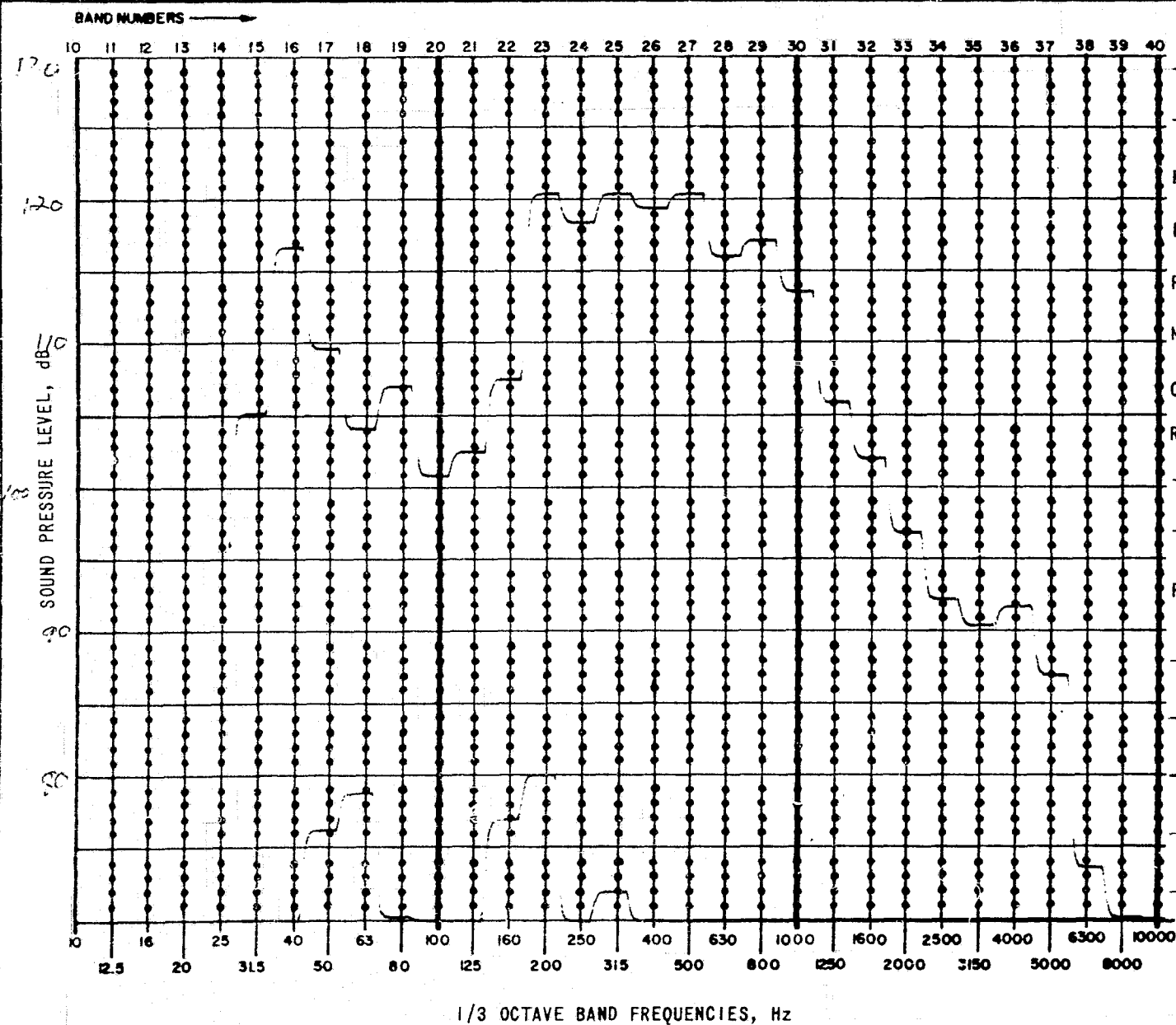
REMARKS 3448. NIM<sup>2</sup>  
(C-5 PSI) Helium

Plot # 53

INTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 34

MICROPHONE NO. 4

OVERALL LEVEL 127.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERTSON

REMARKS (0.5 PSI) HELIUM

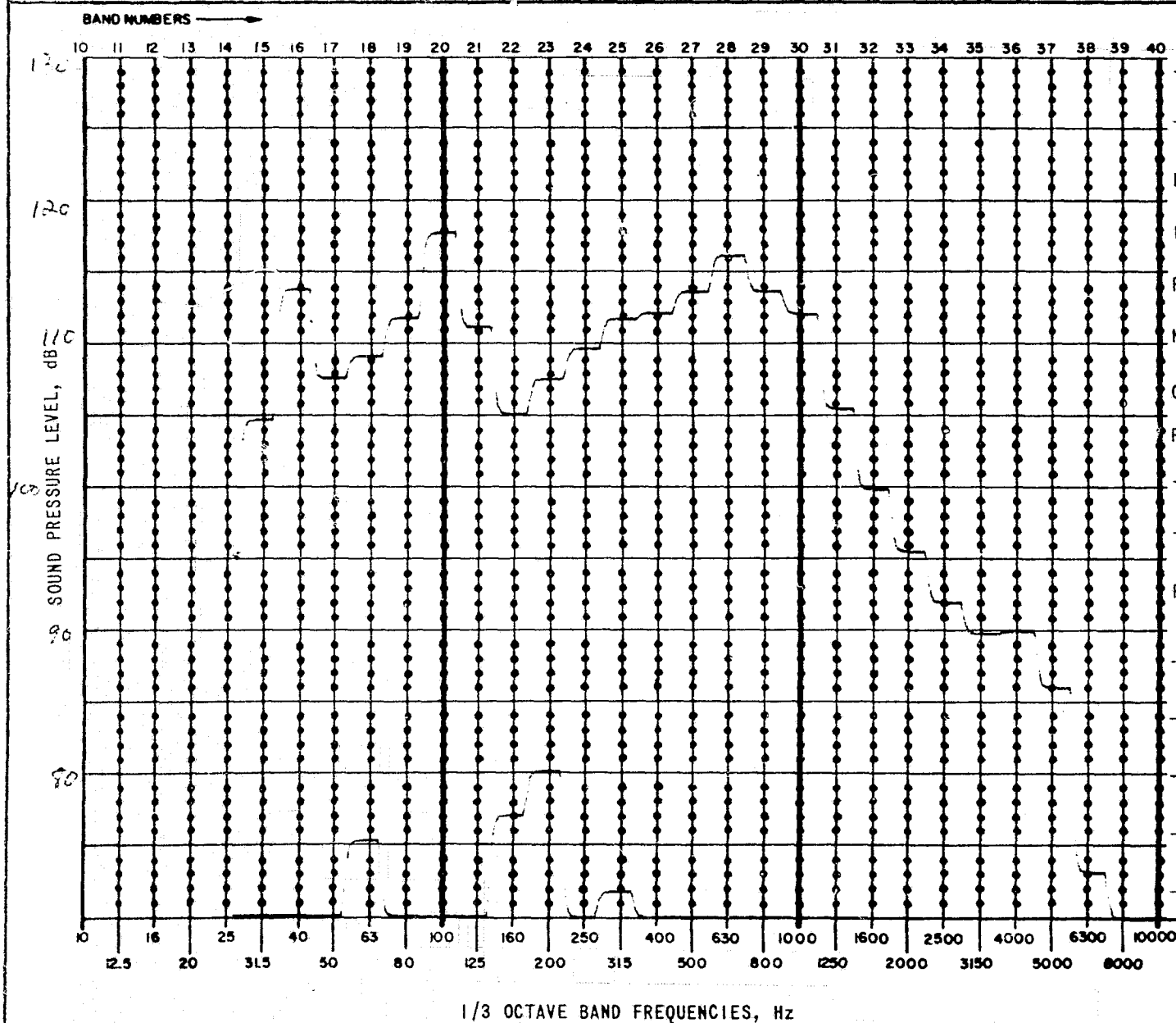
Plot # 54

INTERNAL

A56

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM COMP. SHIELD

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-15-76

RUN NO. 35

MICROPHONE NO. 5

OVERALL LEVEL 124.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

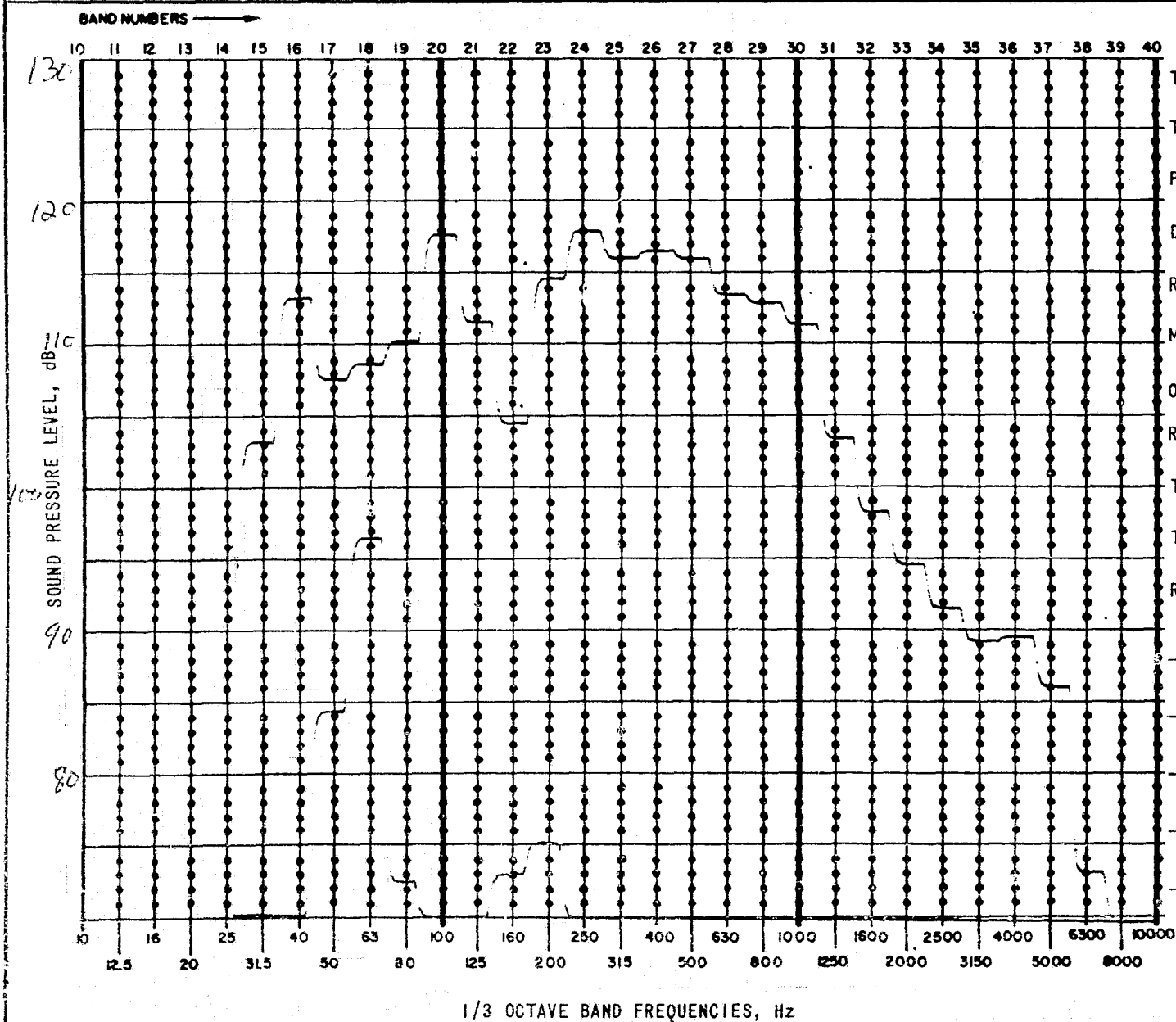
REMARKS 3448 N/M<sup>2</sup>  
(C.5 PSI) HELIUM

Plot # 55

INTERNAL

A57

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-15-76

RUN NO. 36

MICROPHONE NO. 6

OVERALL LEVEL \_\_\_\_\_

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

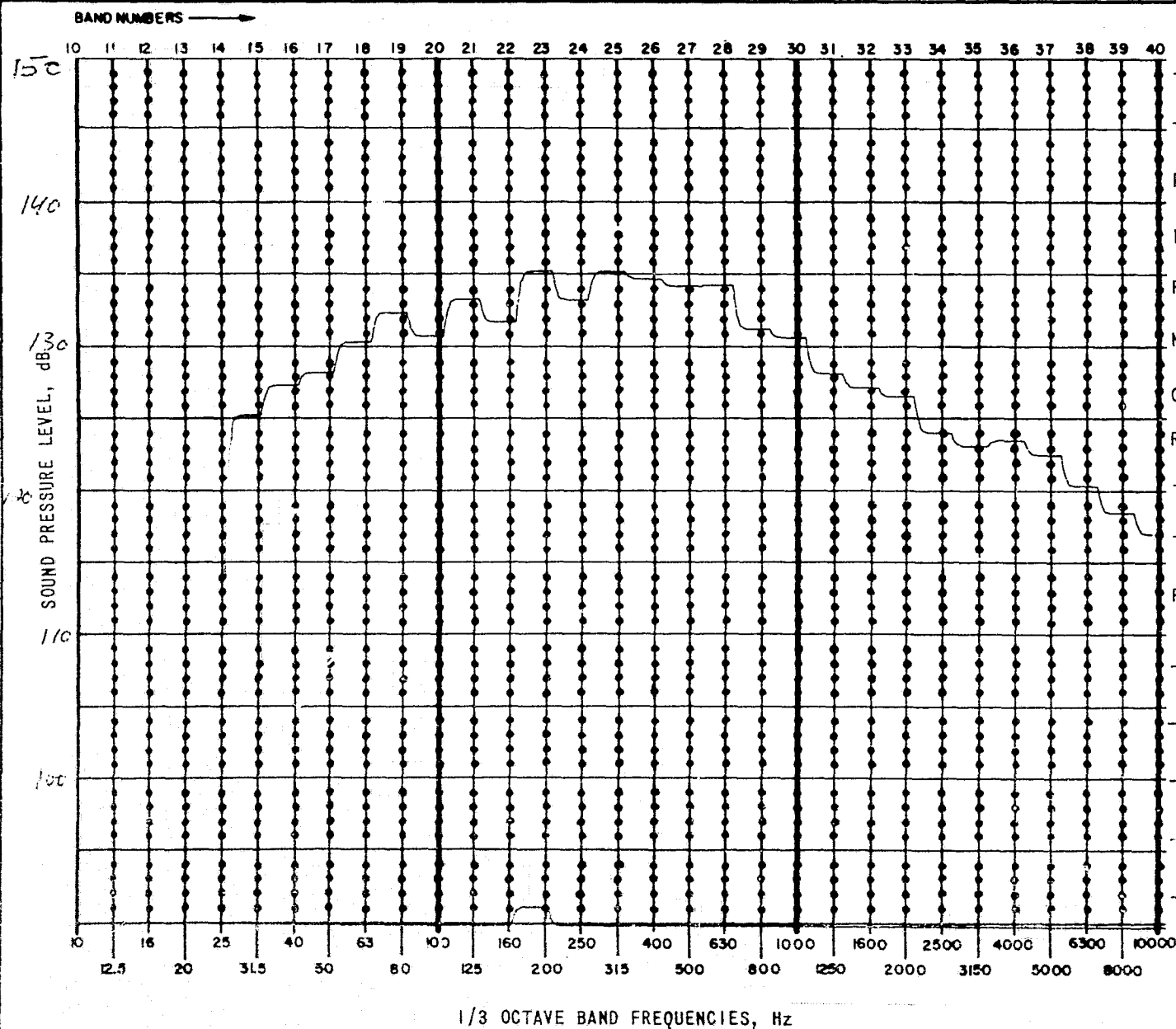
REMARKS 3448. N/m<sup>2</sup>  
(0.5 PSI) HELIUM

Plot #56

INTERNAL

A58

# ACOUSTIC DATA SHEET



TEST ITEM Comp. Shroud  
Liner

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 1

MICROPHONE NO. 1M-6M AUG

OVERALL LEVEL 145 ON 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERTSON

REMARKS BAGS WITH AIR

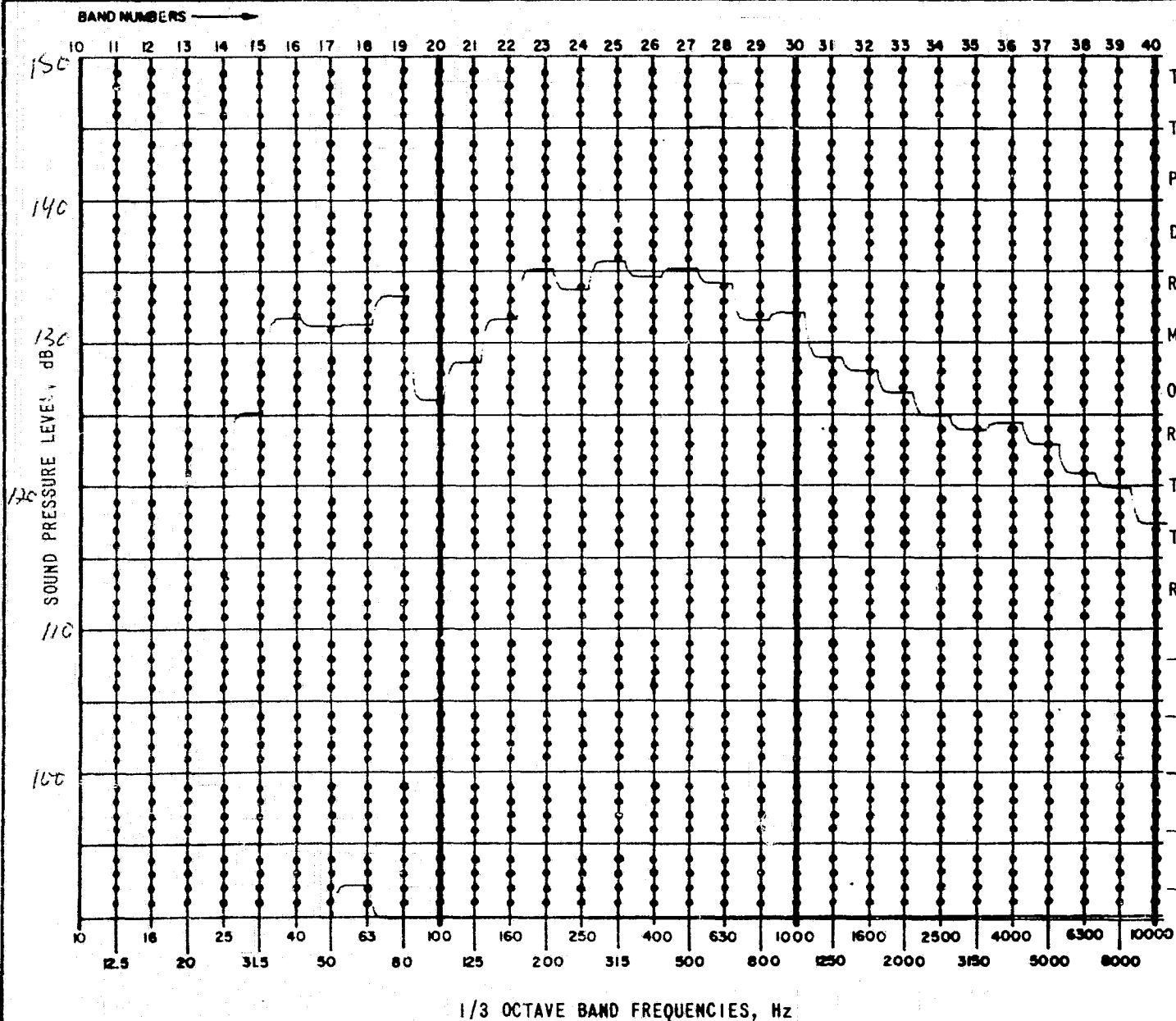
Plot # 57

EXTERNAL MICROPHONE

AVERAGE

A59

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 9

MICROPHONE NO. 1M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

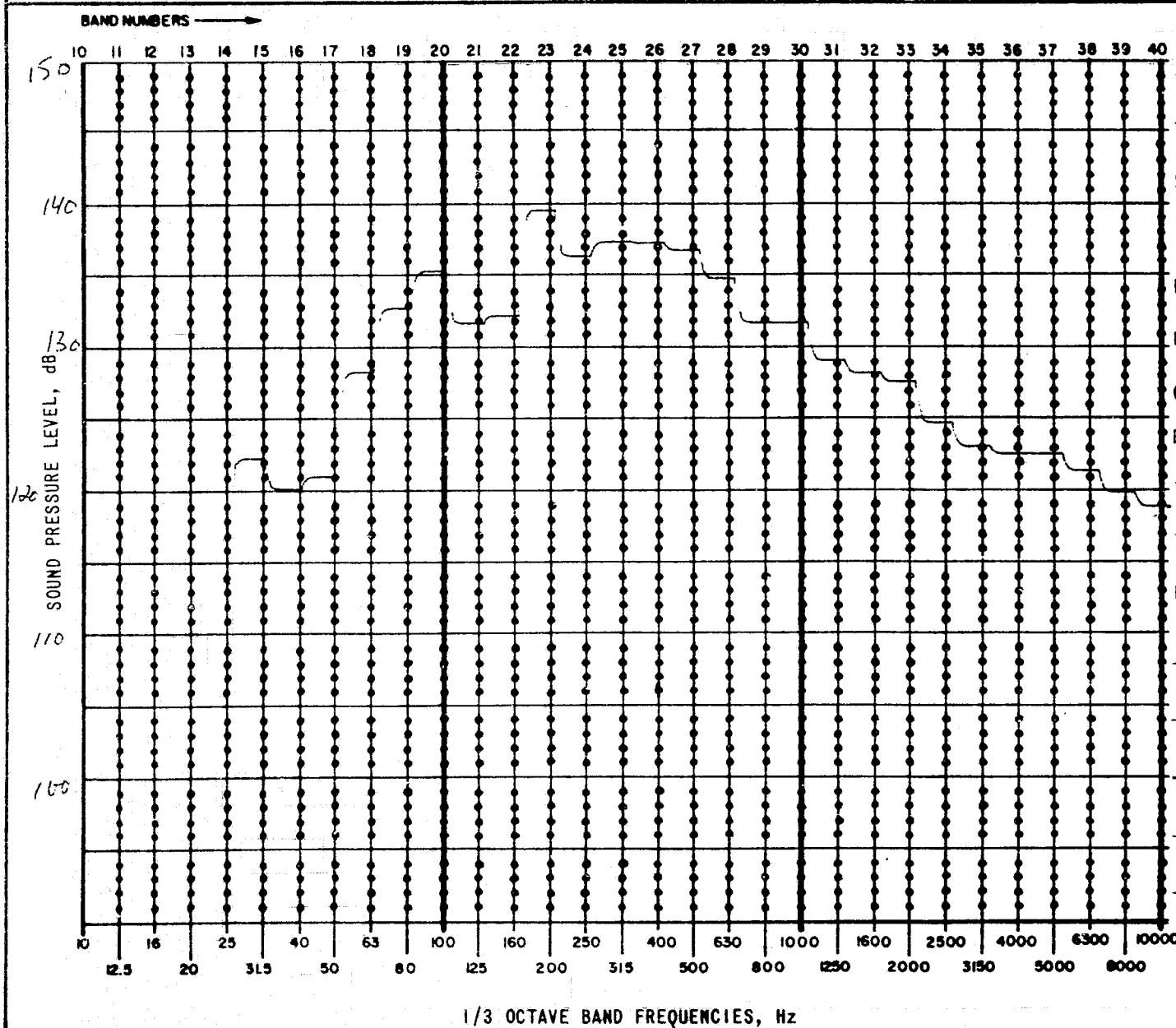
REMARKS AIR IN LINER

Plot #58

EXTERNAL

A60

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 10

MICROPHONE NO. 2M

OVERALL LEVEL 146.5

RUN DURATION 10SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

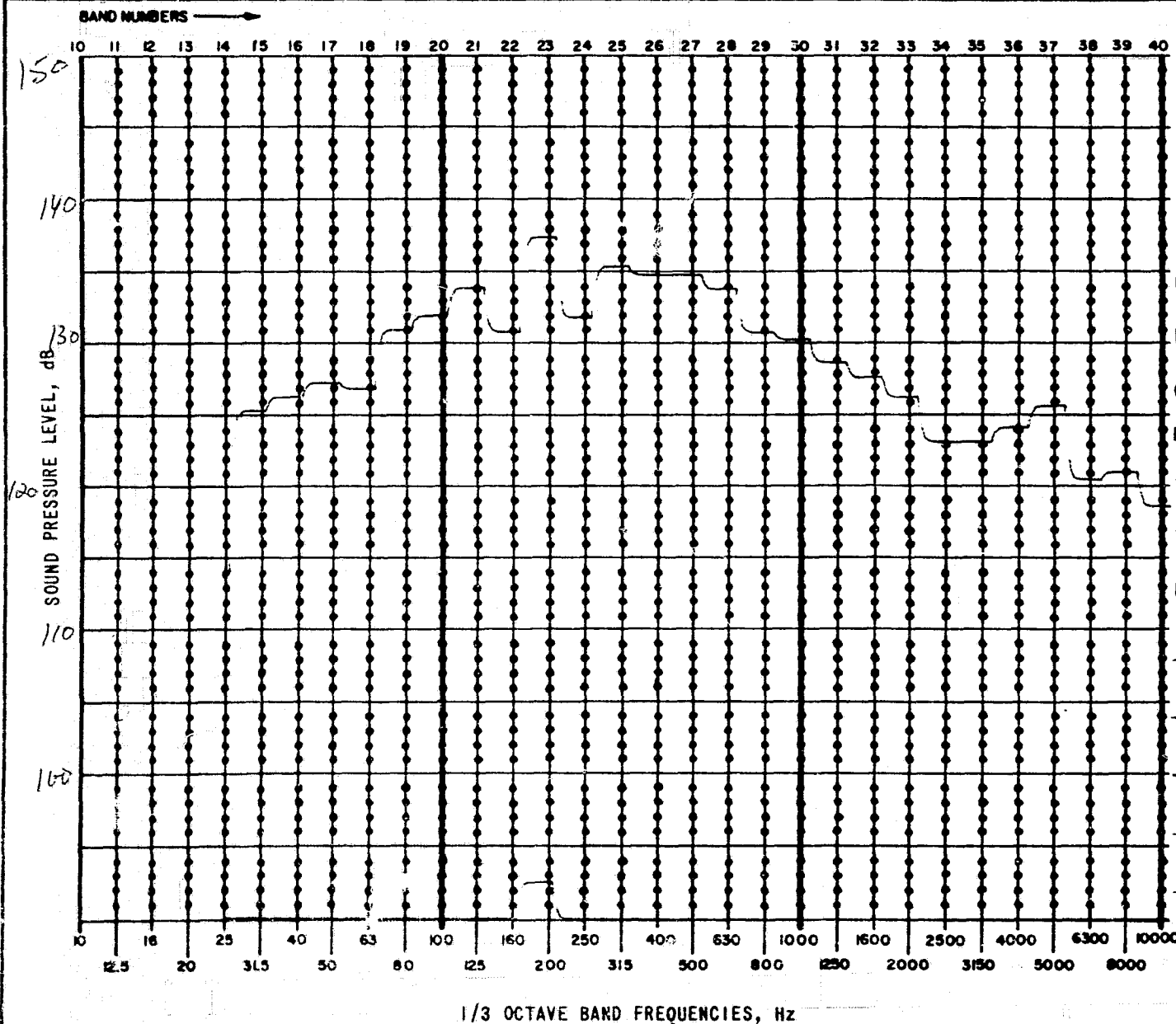
REMARKS AIR IN LINER

Plot # 59

EXTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 11

MICROPHONE NO. 3M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

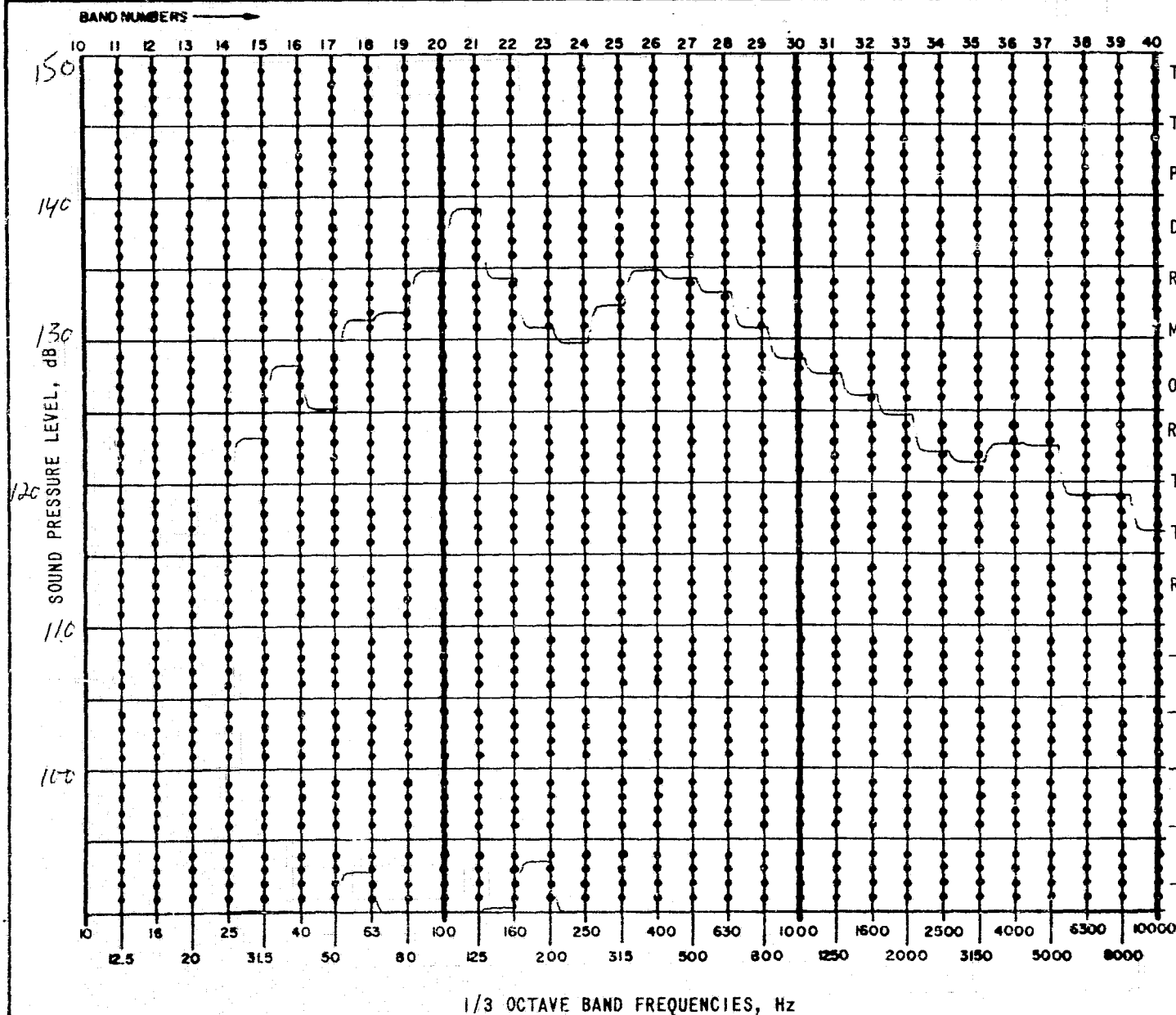
TEST TECHNICIAN ROBERSON

REMARKS AIR IN LINER

Plot #60

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-17-76

RUN NO. 12

MICROPHONE NO. 4M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

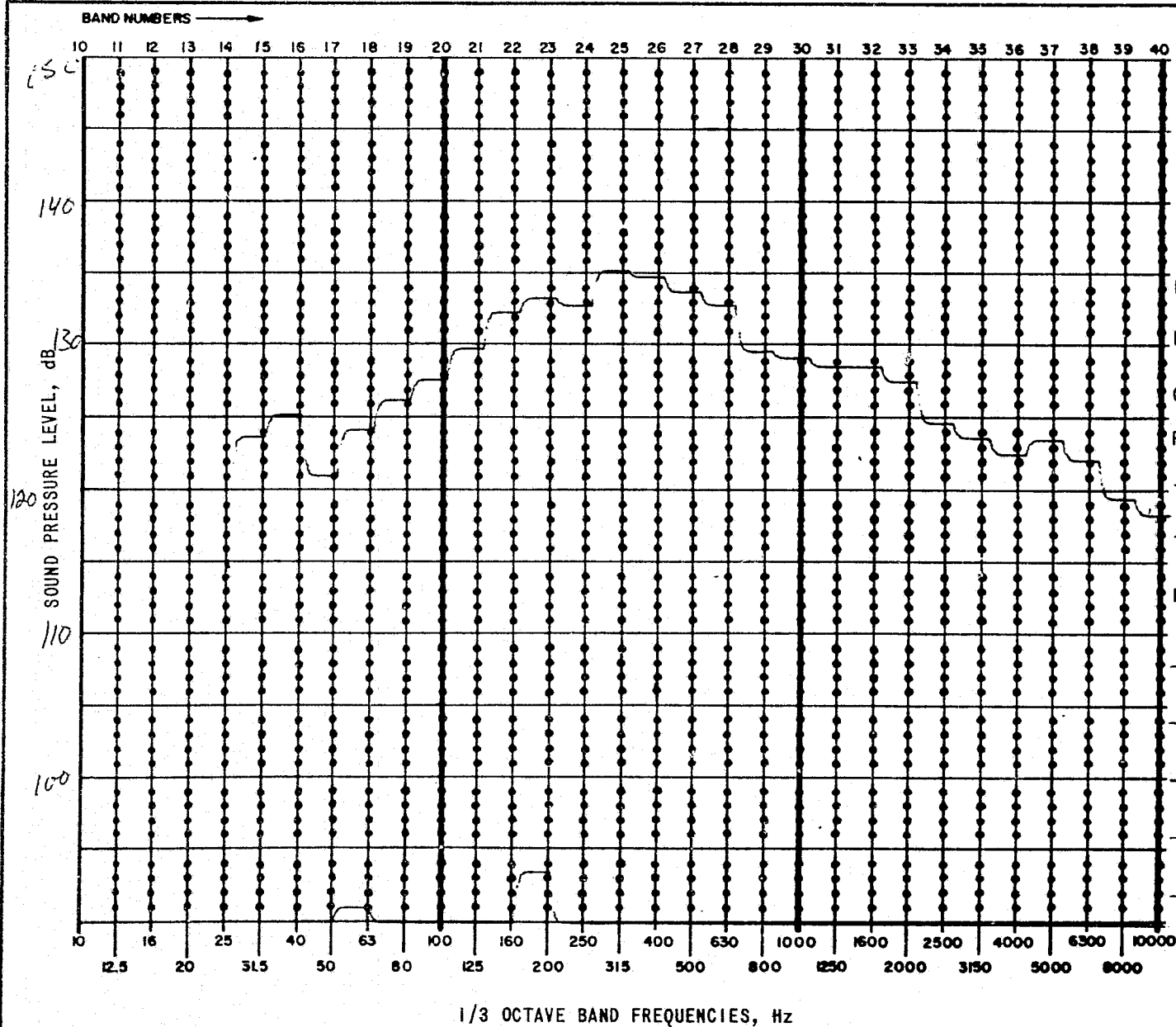
TEST TECHNICIAN ROBERSON

REMARKS AIR IN LINER

Plot # 61

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 13

MICROPHONE NO. 5M

OVERALL LEVEL 143.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

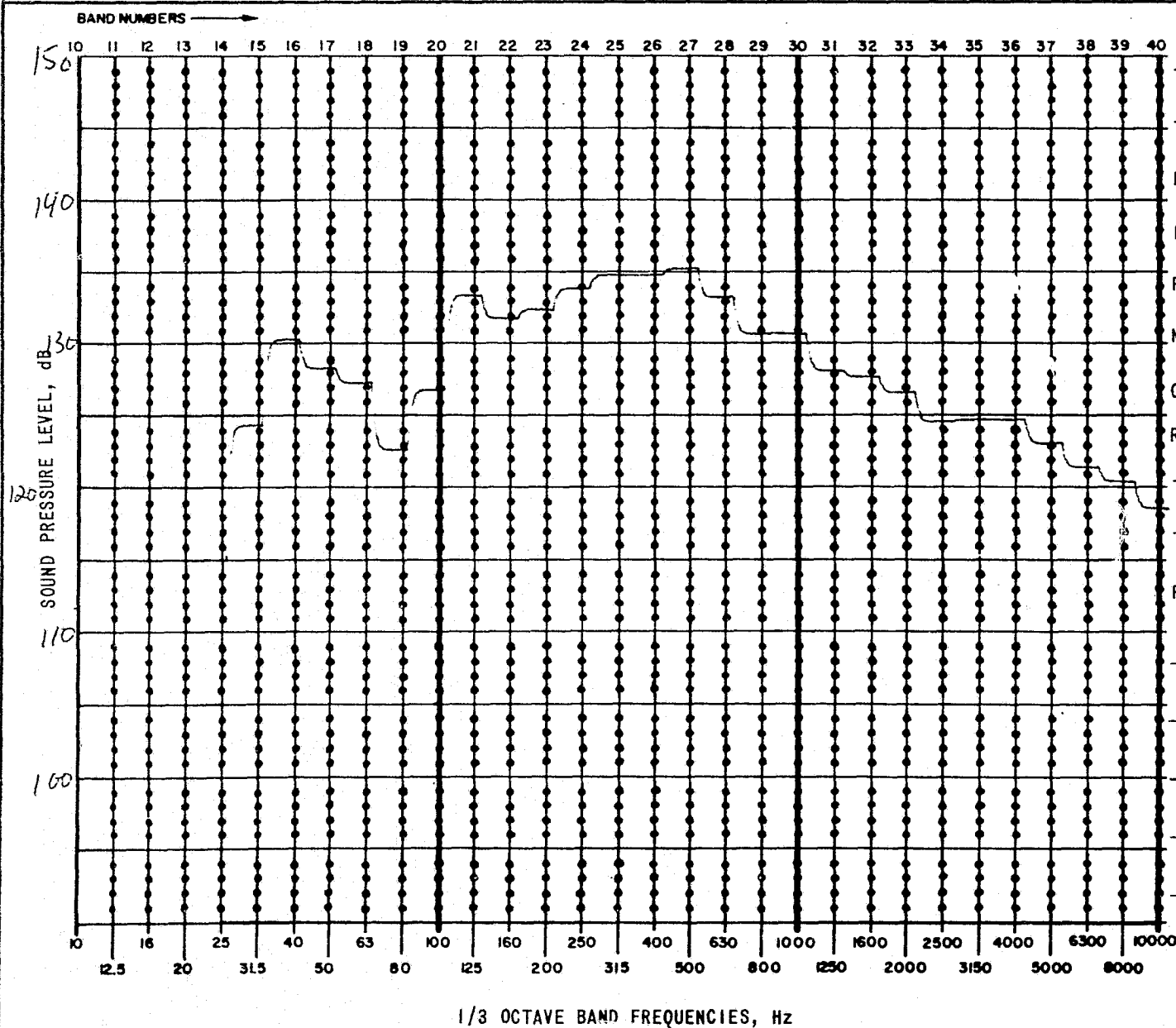
TEST TECHNICIAN ROBERSON

REMARKS AIR IN LINER

Plot # 62

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 4-17-76

RUN NO. 14

MICROPHONE NO. 6M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

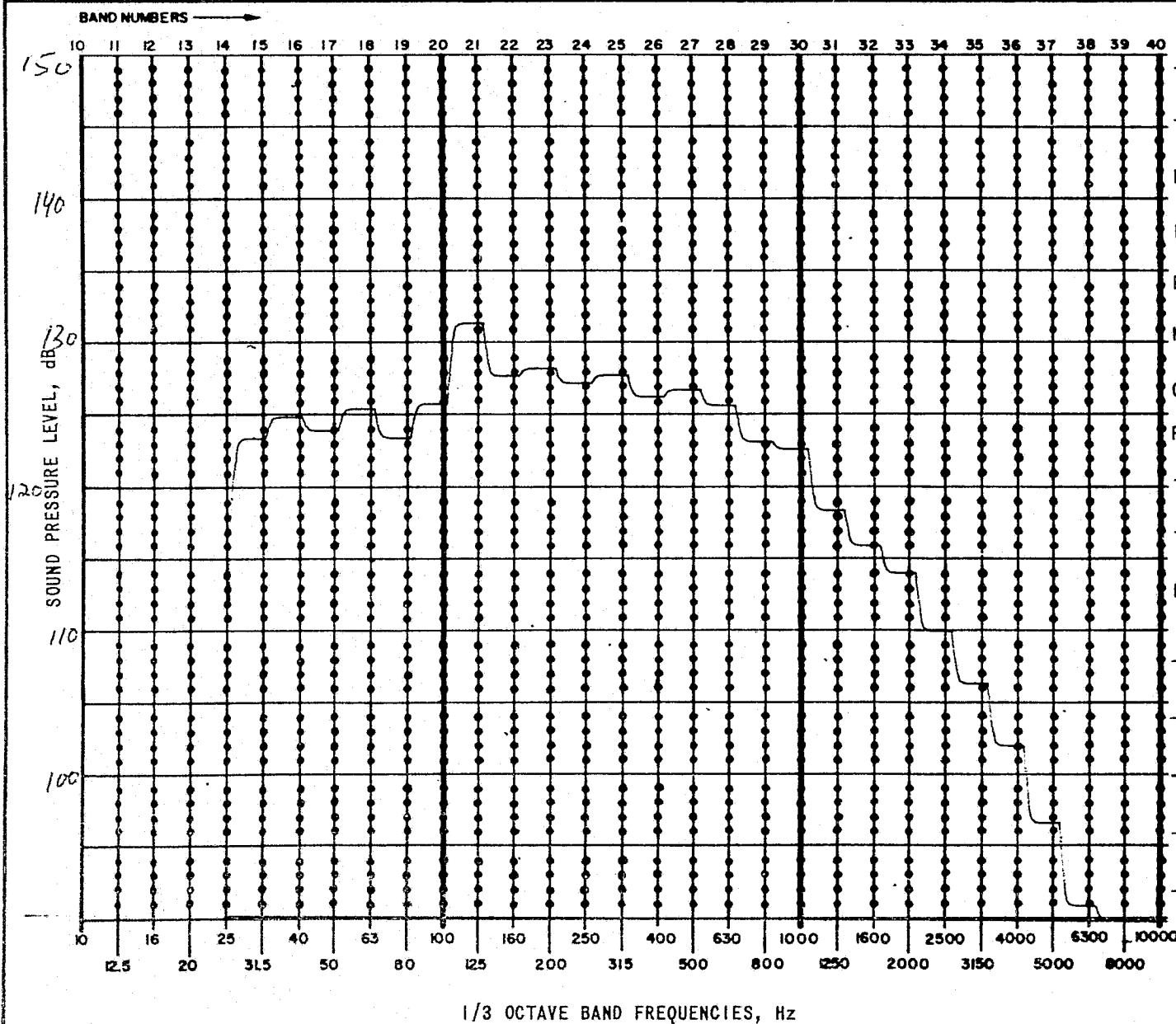
TEST TECHNICIAN RODERSEN

REMARKS AIR IN LINER

Plot #63

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SE

DATE 9-17-76

RUN NO. 2

MICROPHONE NO. 1-6 AUG

OVERALL LEVEL 1450N/M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS AIR IN LINER

Plot # 64

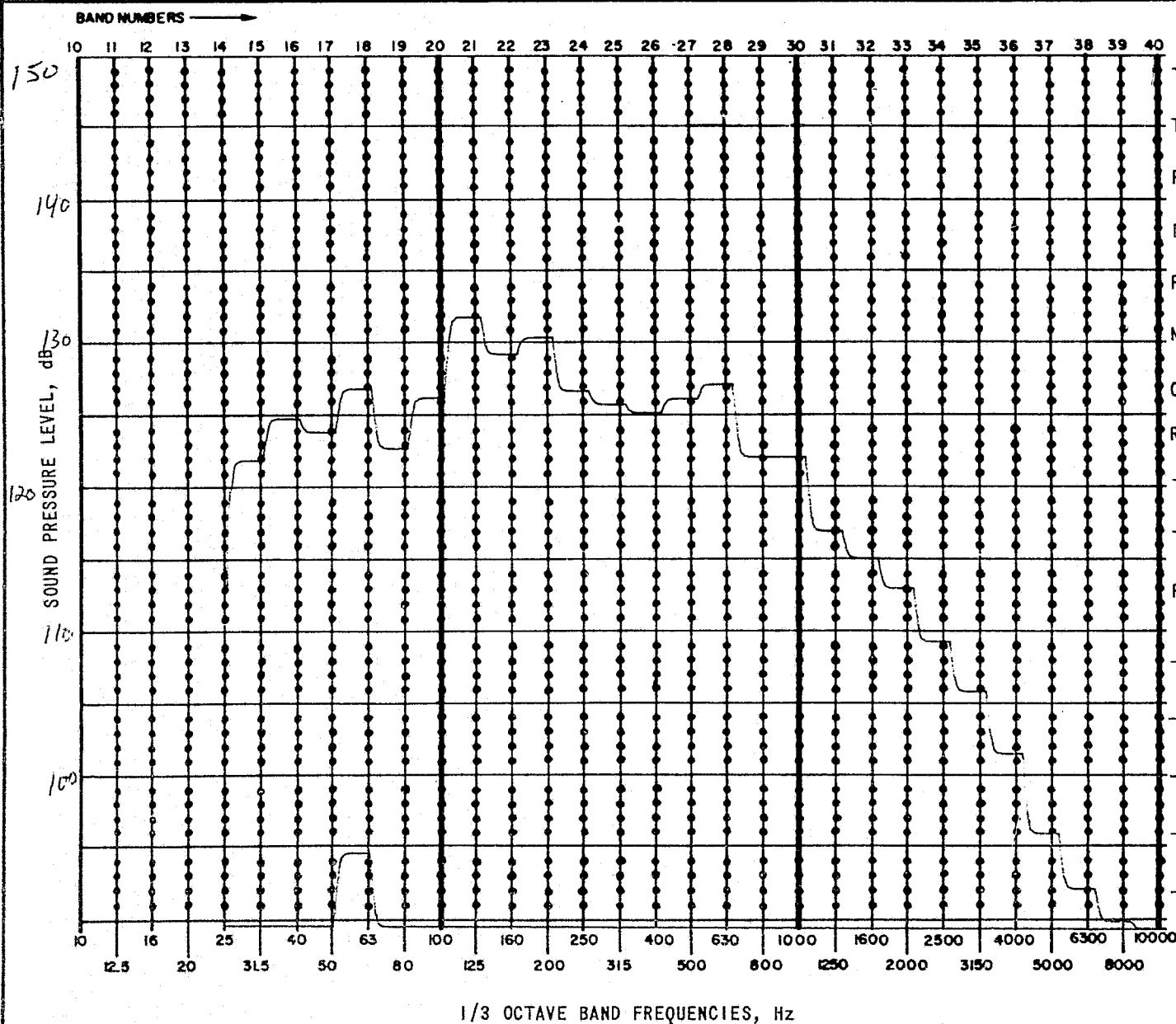
INTERNAL MICROPHONE

AVERAGE

A66

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 3

MICROPHONE NO. 1

OVERALL LEVEL 139

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

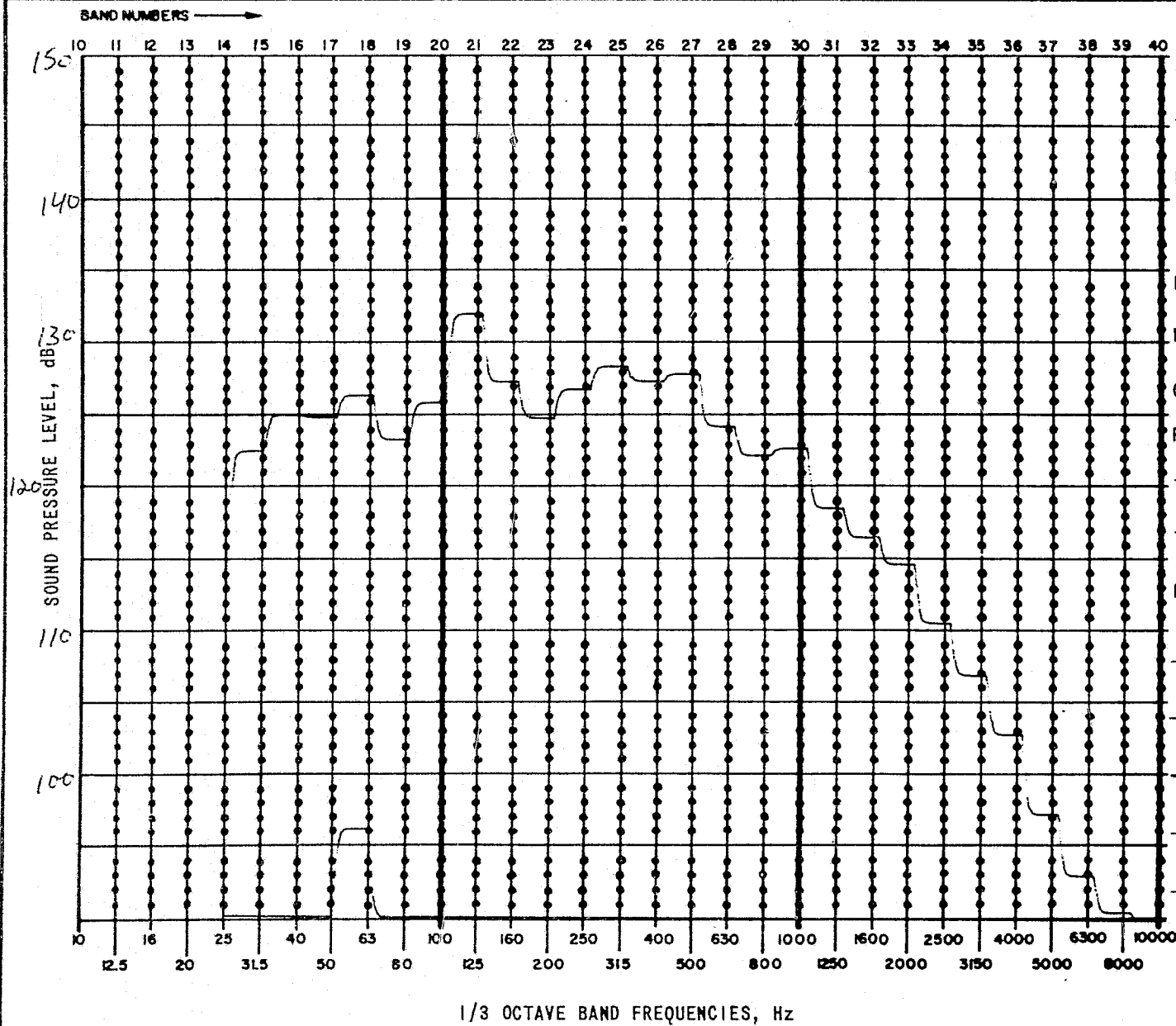
TEST TECHNICIAN ROBERSON

REMARKS AIR IN - INER

Plot #65

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 4

MICROPHONE NO. 2

OVERALL LEVEL 138

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

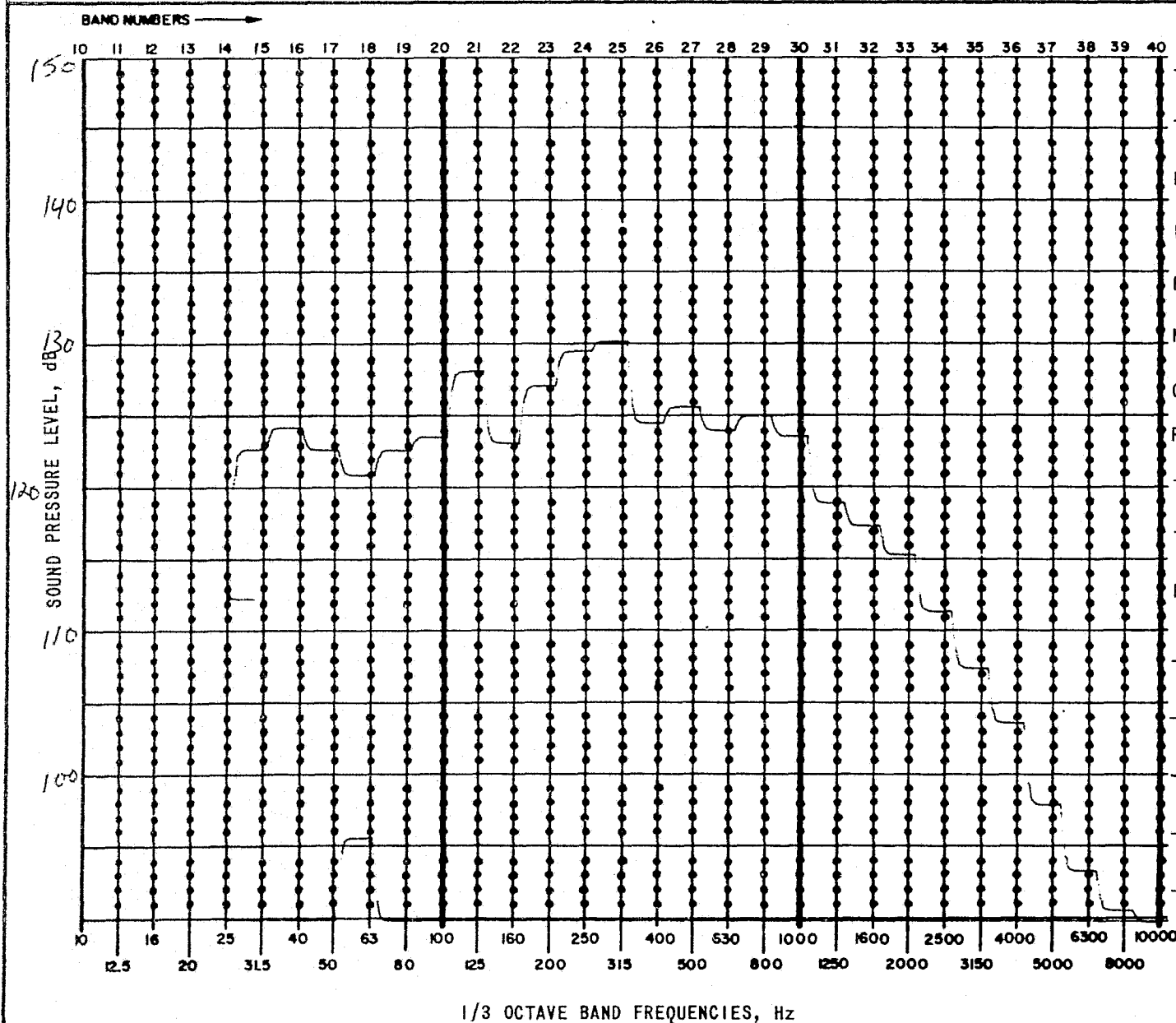
REMARKS AIR IN LINER

Plot #66

INTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM LINEAR

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 5

MICROPHONE NO. 3

OVERALL LEVEL 137.5

RUN DURATION 10 SEC.

TEST ENGINEER SNYDER

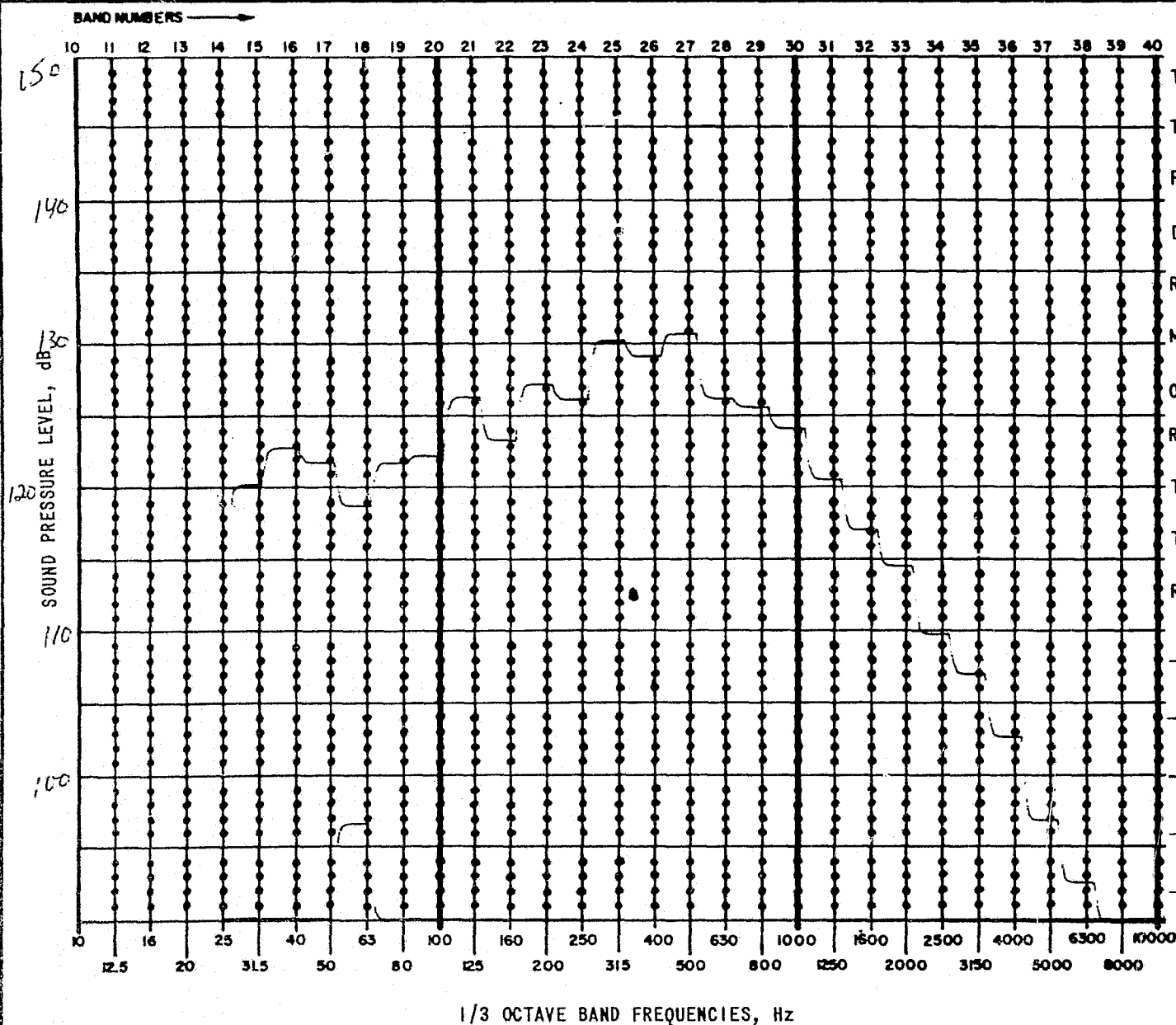
TEST TECHNICIAN ROBINSON

REMARKS AIR IN LINE

Plot # 67

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 6

MICROPHONE NO. 4

OVERALL LEVEL 138

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS AIR IN LINER

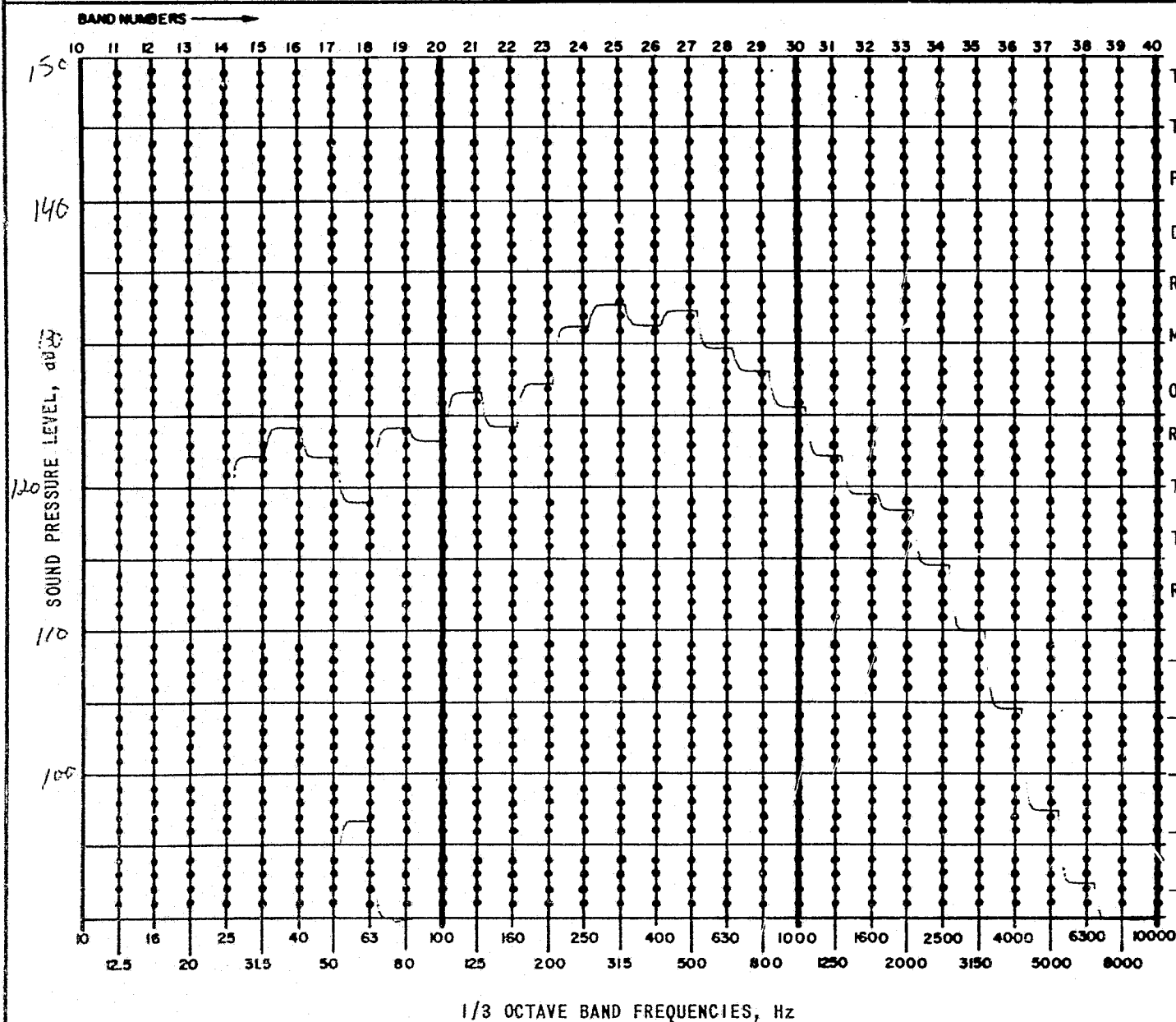
Plot # 68

INTERNAL

A70

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST Env

PROGRAM SS

DATE 9-17-76

RUN NO. 7

MICROPHONE NO. 5

OVERALL LEVEL 140

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

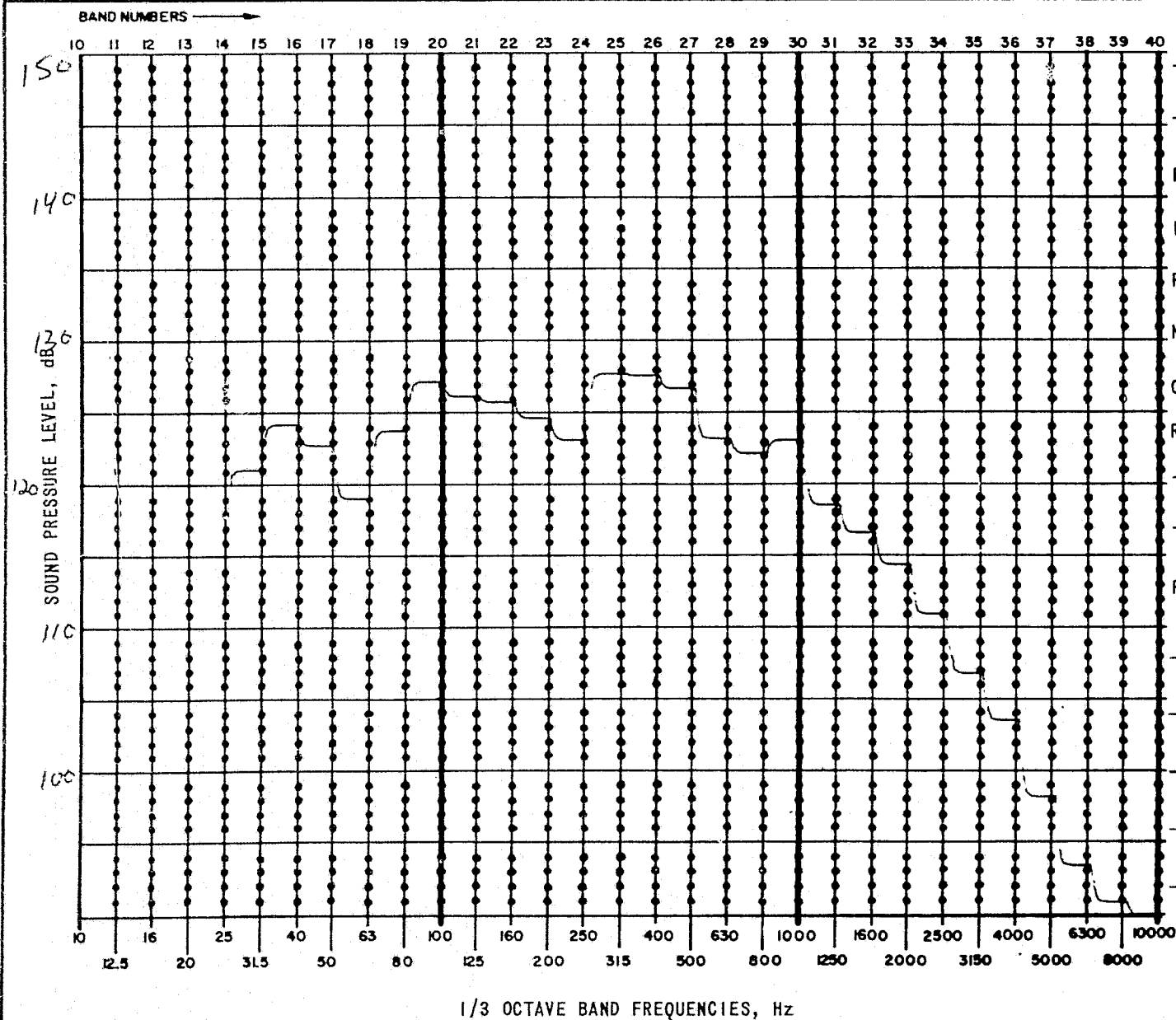
TEST TECHNICIAN GREENSON

REMARKS AIR IN LINER

Plot # 69

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 8

MICROPHONE NO. 6

OVERALL LEVEL 134.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

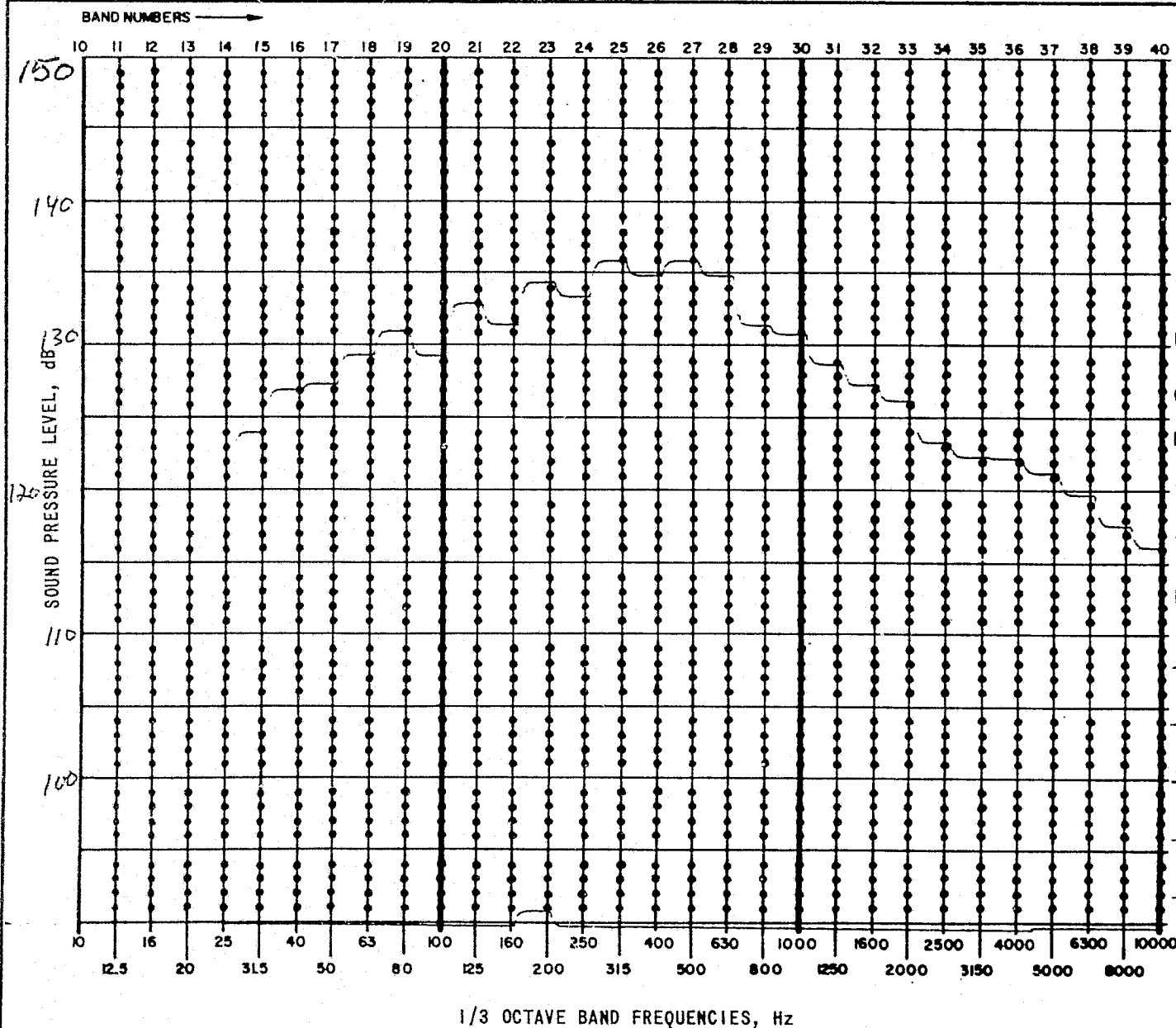
REMARKS AIR IN LINER

Plot #70

INTERNAL

A72

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 15

MICROPHONE NO. IM-6A AUG

OVERALL LEVEL 145 ON IM

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

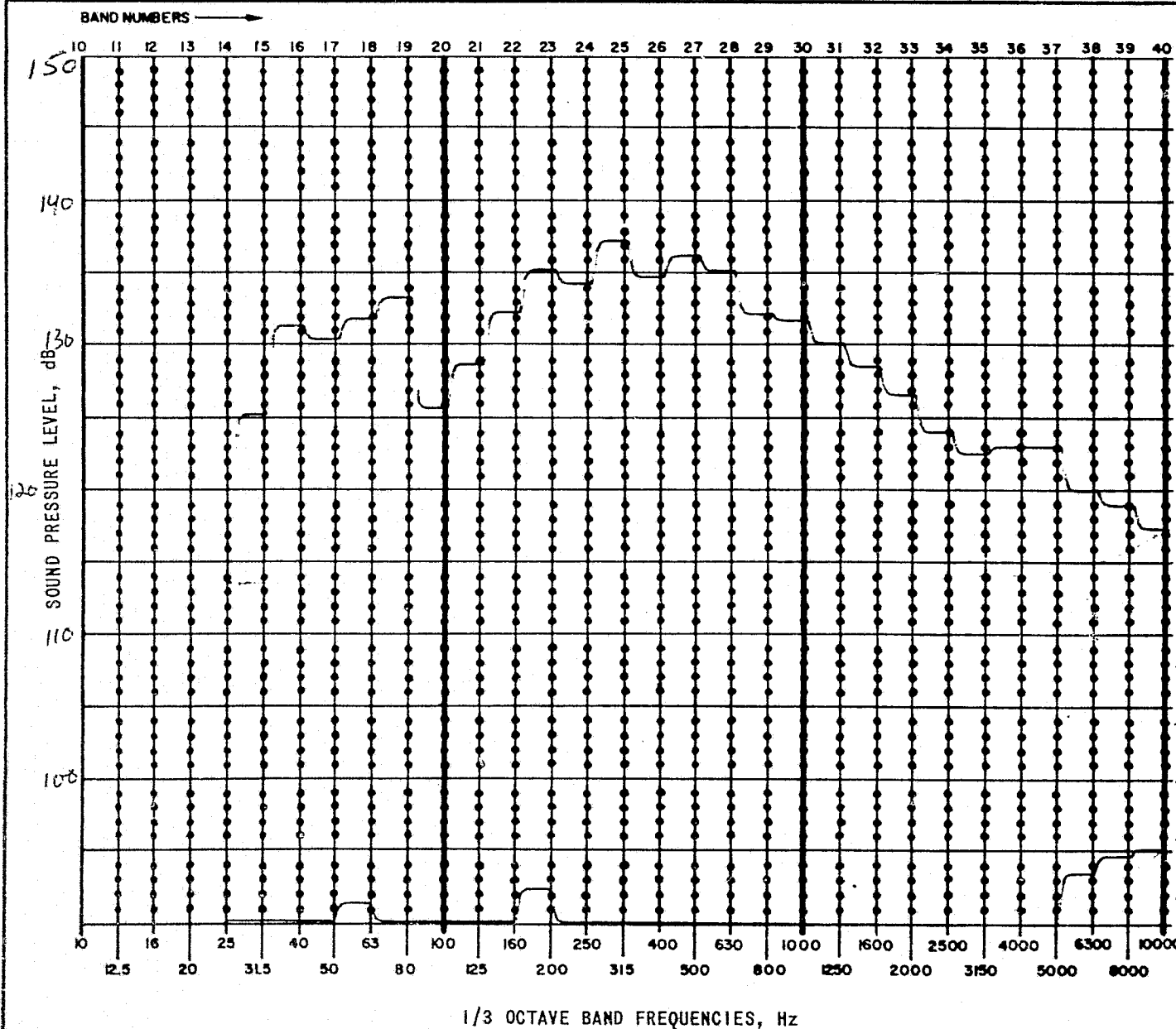
REMARKS HELIX IN LINER

Plot # 71

EXTERNAL MICROPHONE

AVERAGE

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-17-76

RUN NO. 23

MICROPHONE NO. 1M

OVERALL LEVEL 145

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

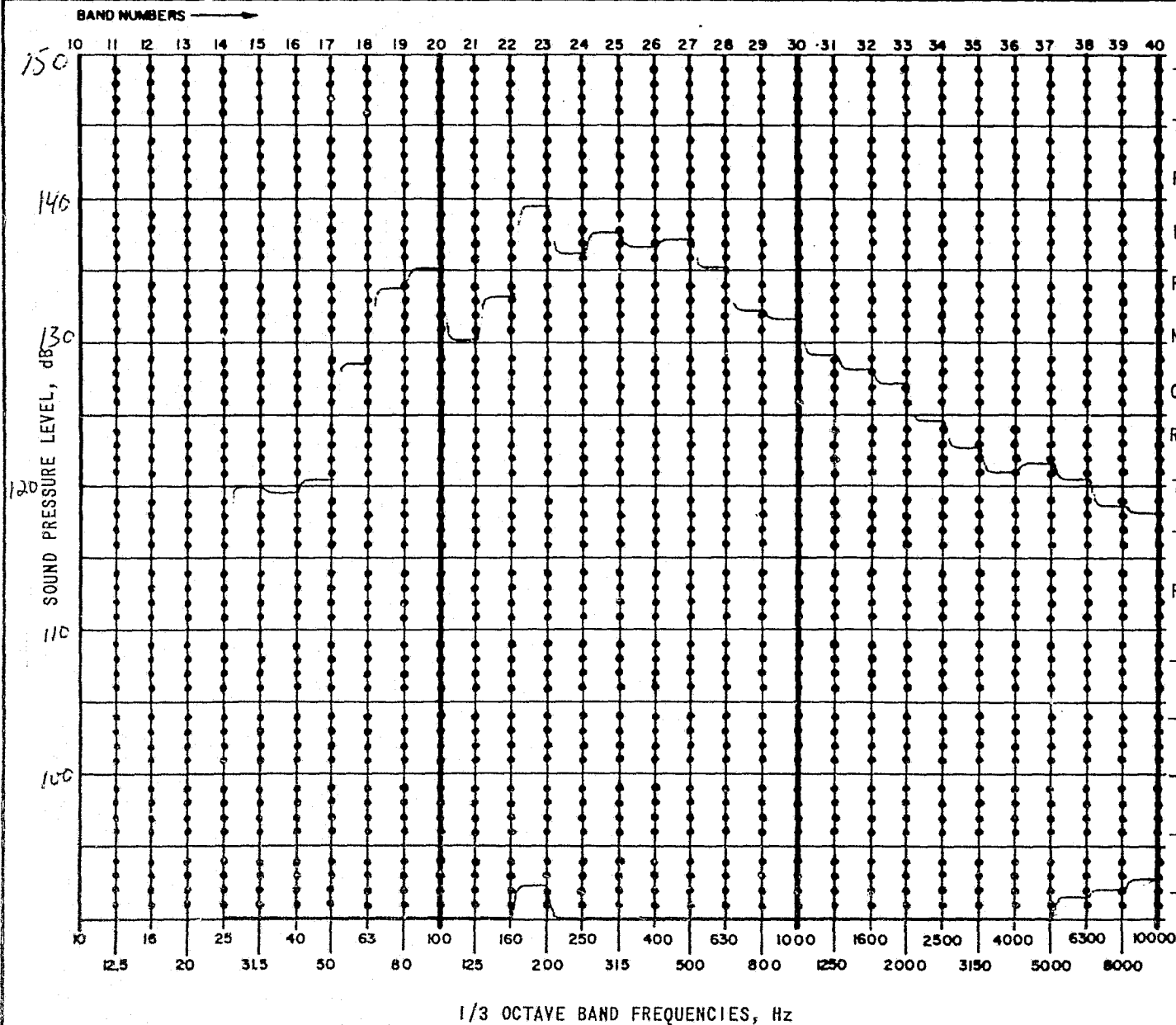
TEST TECHNICIAN ROBERSON

REMARKS HELIUM

Plot #72

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM 35

DATE 9-17-76

RUN NO. 29

MICROPHONE NO. 2W

OVERALL LEVEL 146.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERTSON

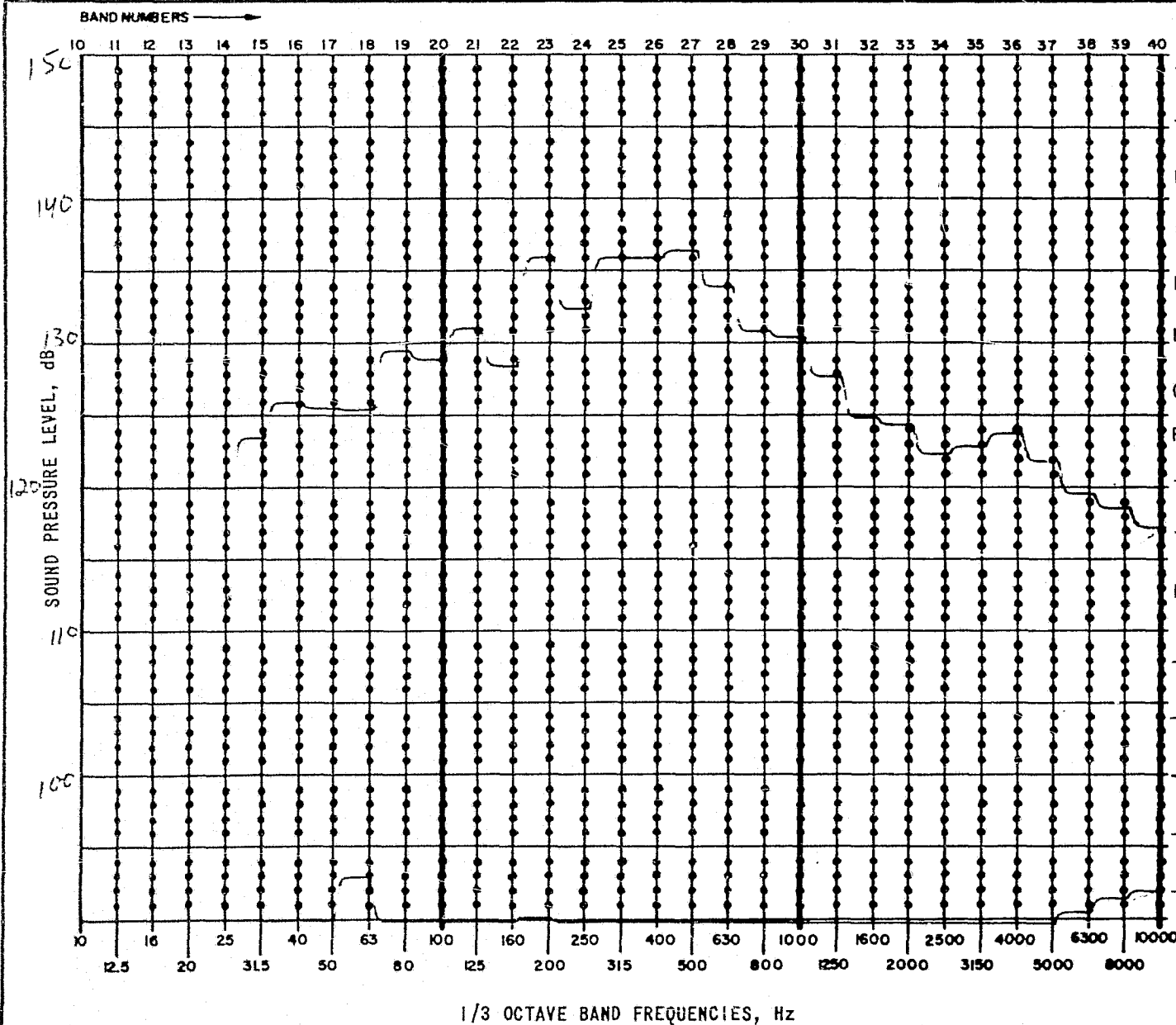
REMARKS HELIUM

Plot # 73

EXTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM ES

DATE 9-17-76

RUN NO. 25

MICROPHONE NO. 3M

OVERALL LEVEL 145

RUN DURATION 10 SEC.

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS HELIUM

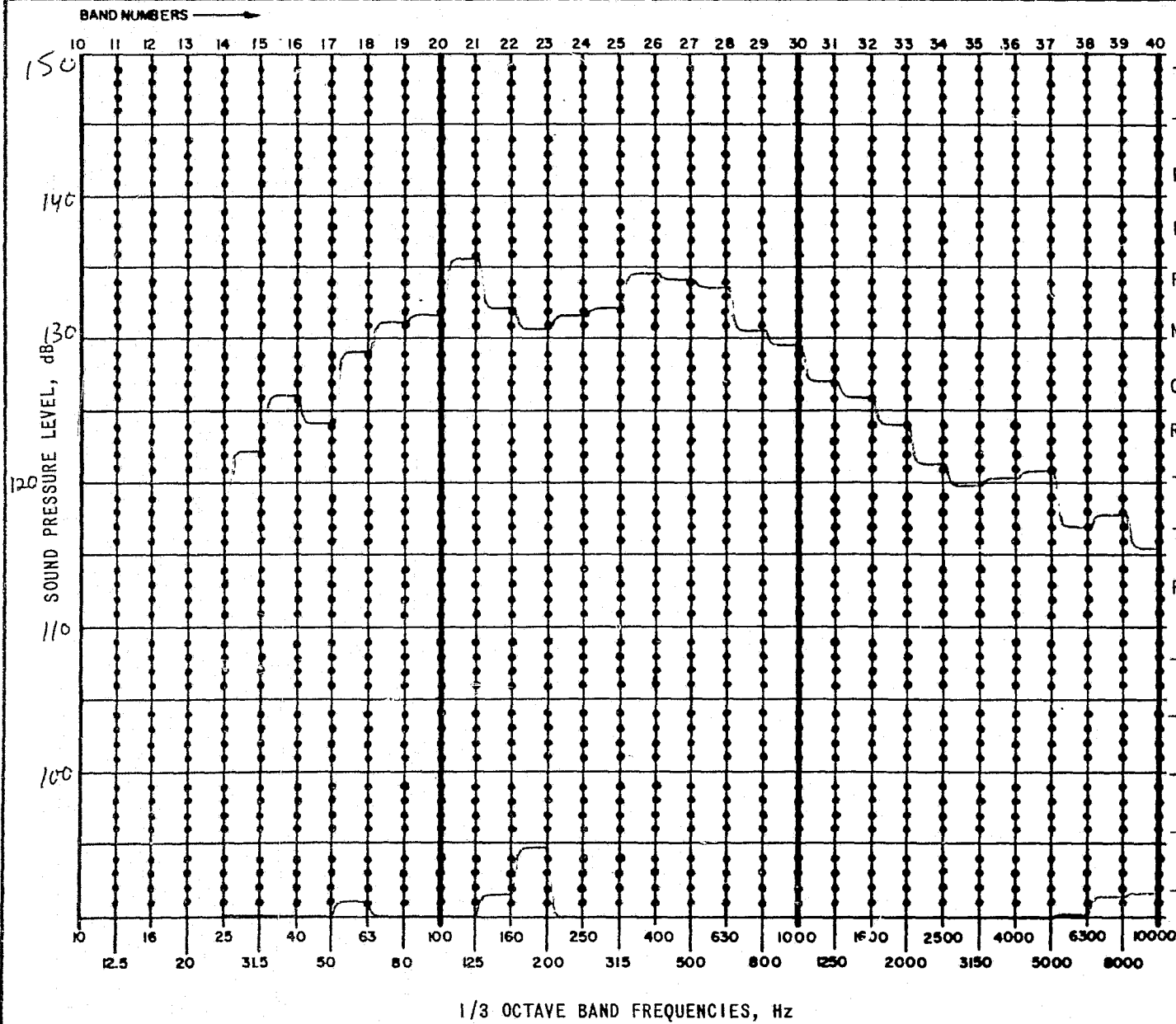
Plot # 74

EXTERNAL

A76

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 4-17-76

RUN NO. 26

MICROPHONE NO. 4M

OVERALL LEVEL \_\_\_\_\_

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERTSON

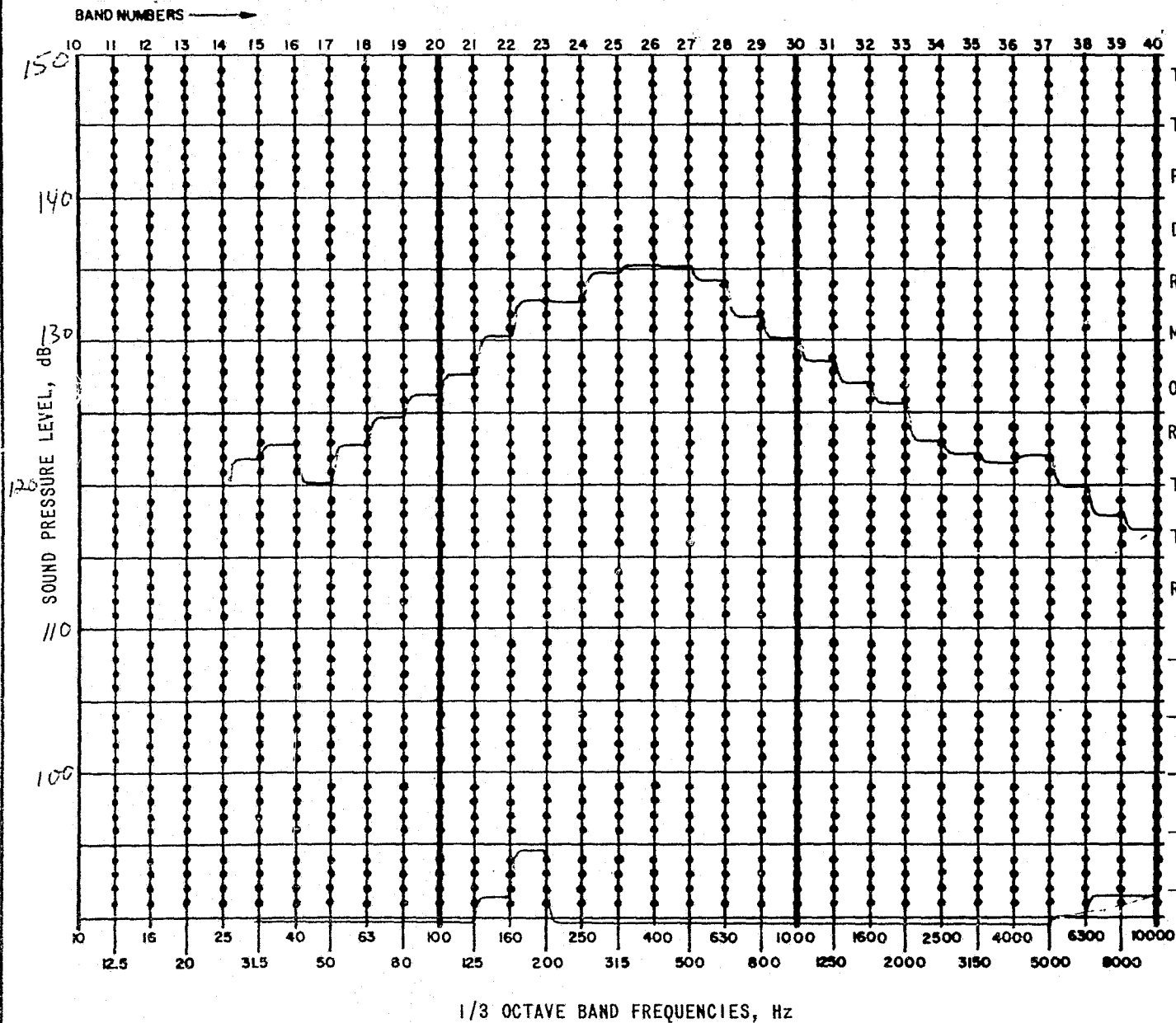
REMARKS HELIUM

Plot # 75

EXTERNAL

A77

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 27

MICROPHONE NO. 5M

OVERALL LEVEL 144

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

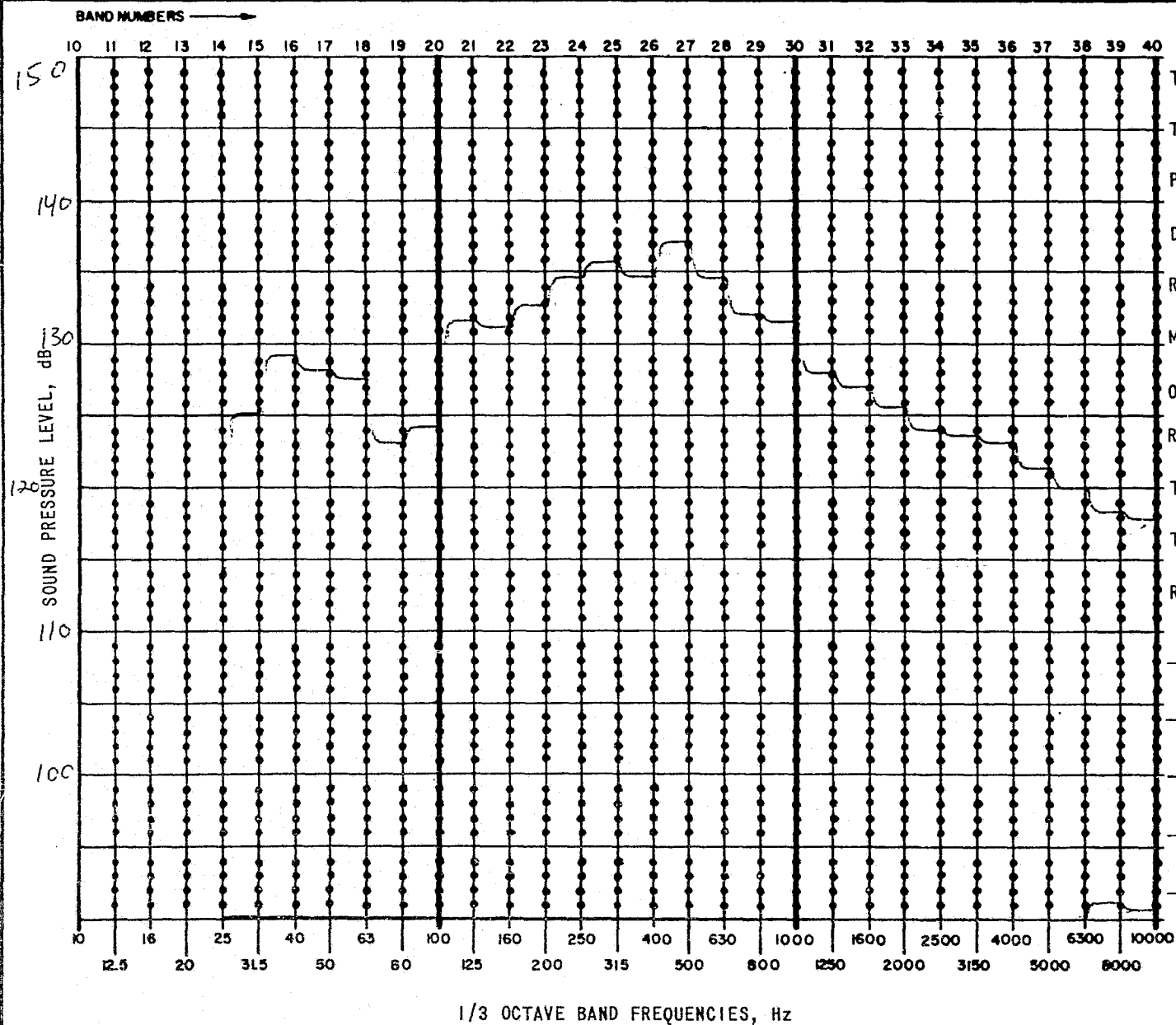
TEST TECHNICIAN ROBERSON

REMARKS HELIUM

Plot # 76

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 28

MICROPHONE NO. 6M

OVERALL LEVEL \_\_\_\_\_

RUN DURATION 10 SEC

TEST ENGINEER SIN Y DER

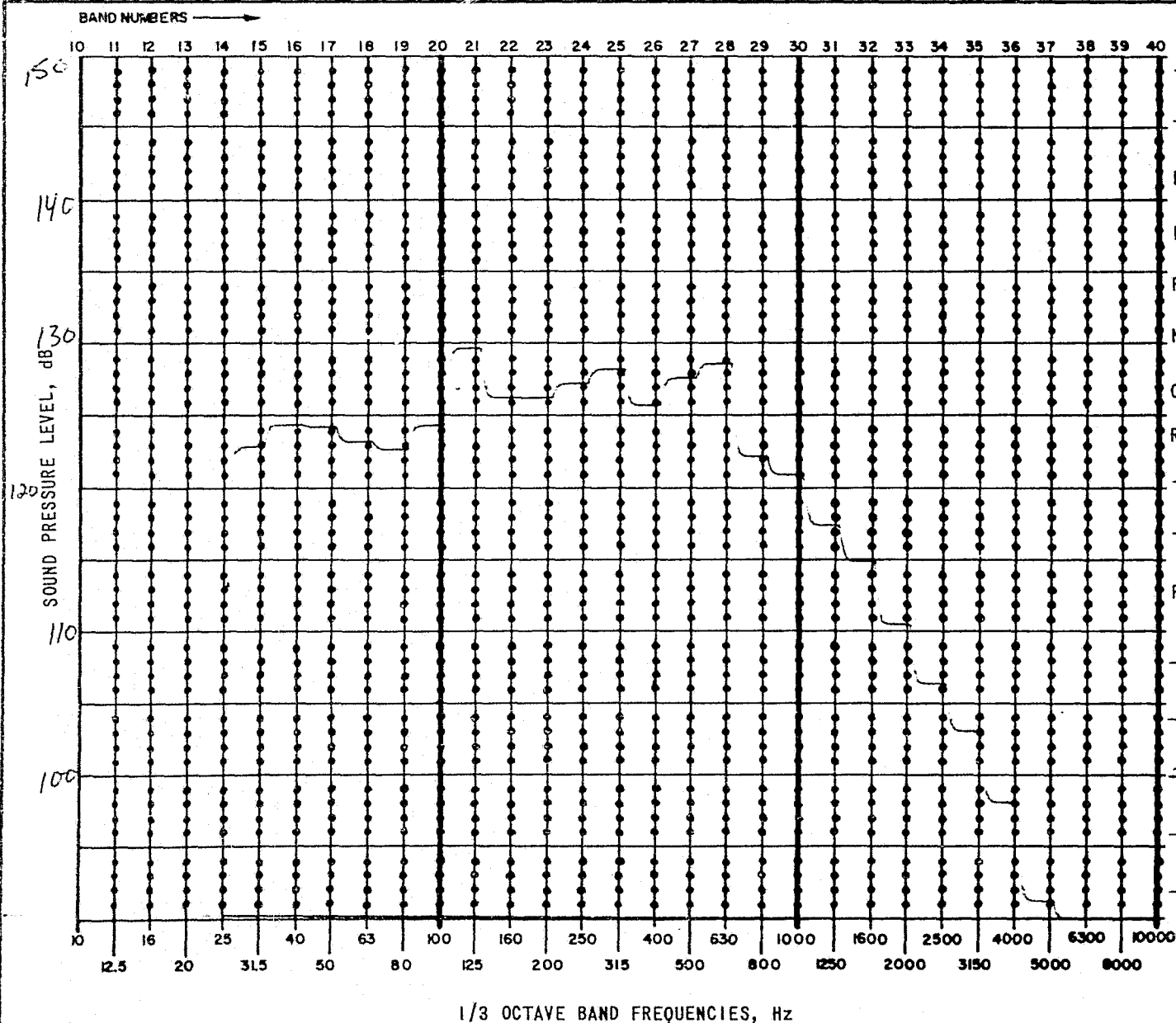
TEST TECHNICIAN ROBERSON

REMARKS HELIUM

Plot # 77

EXTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 16

MICROPHONE NO. 1-6 AVG

OVERALL LEVEL 145 ON 1M

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS HELIUM

Plot # 78

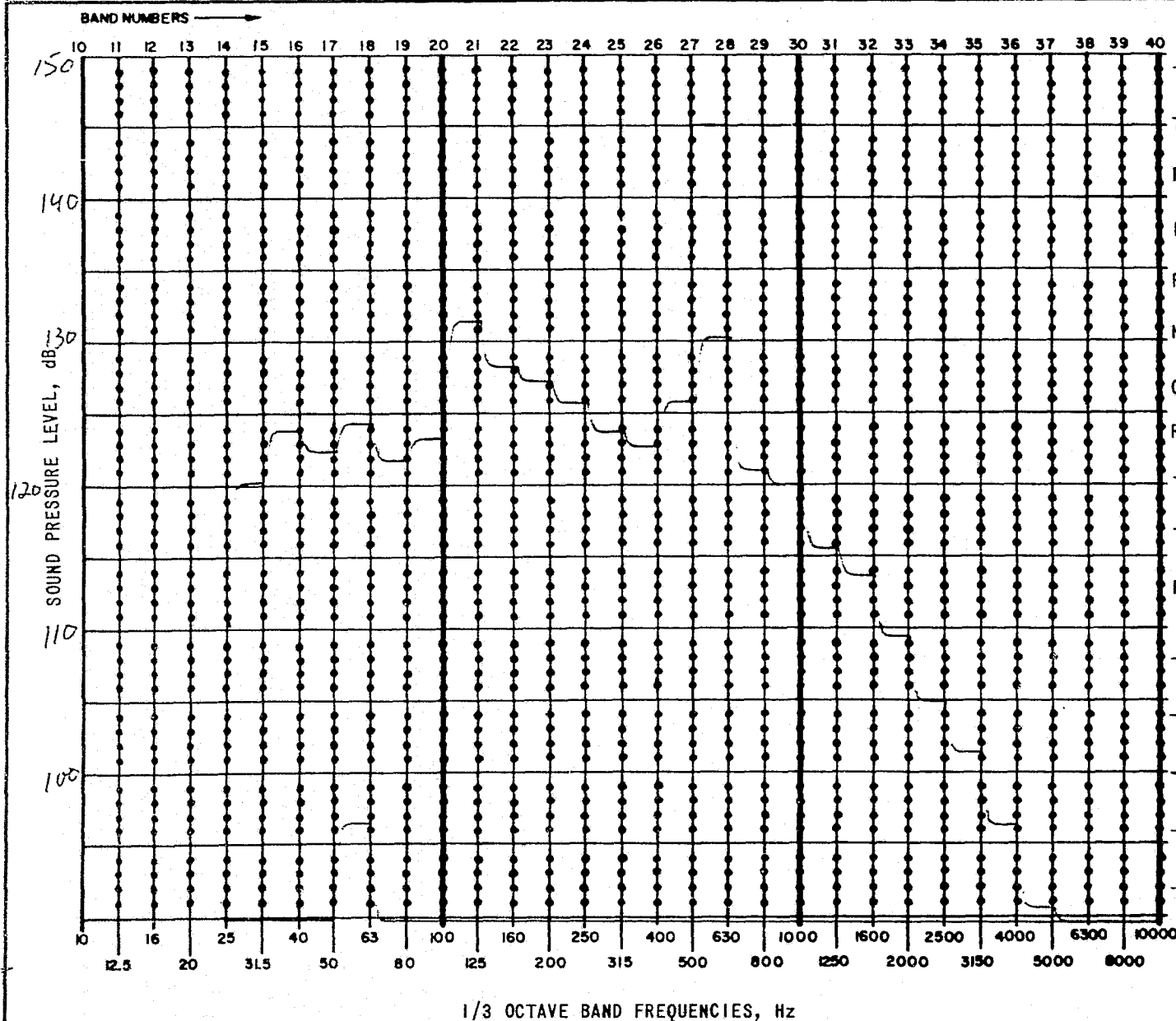
INTERNAL MICROPHONE

AVERAGE

A80

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST Equal

PROGRAM SS

DATE 7-17-76

RUN NO. 17

MICROPHONE NO. 1

OVERALL LEVEL 138

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

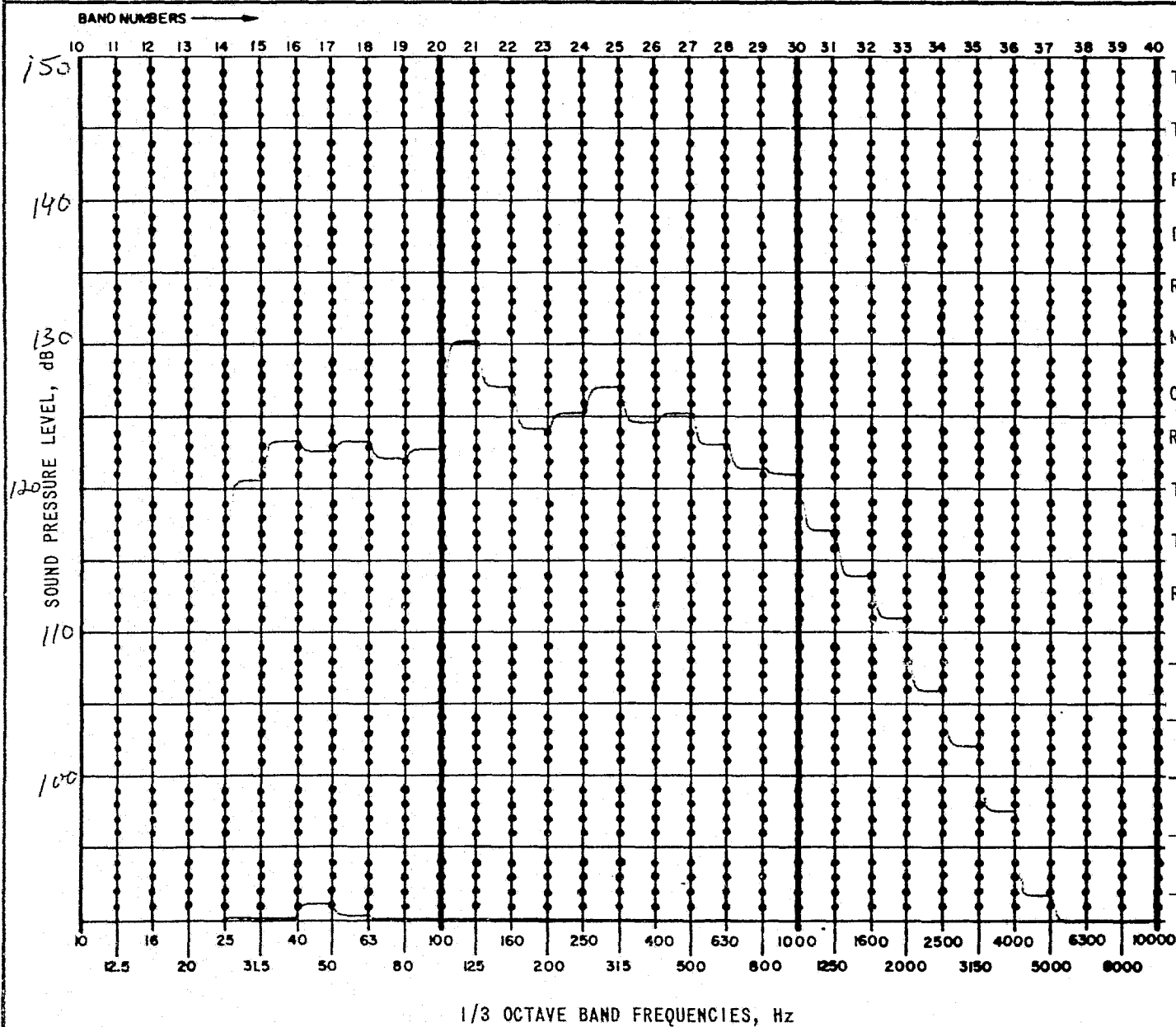
TEST TECHNICIAN ROBERSON

REMARKS Helium

Plot # 79

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL.

PROGRAM SS

DATE 9-17-76

RUN NO. 18

MICROPHONE NO. 2

OVERALL LEVEL 147

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

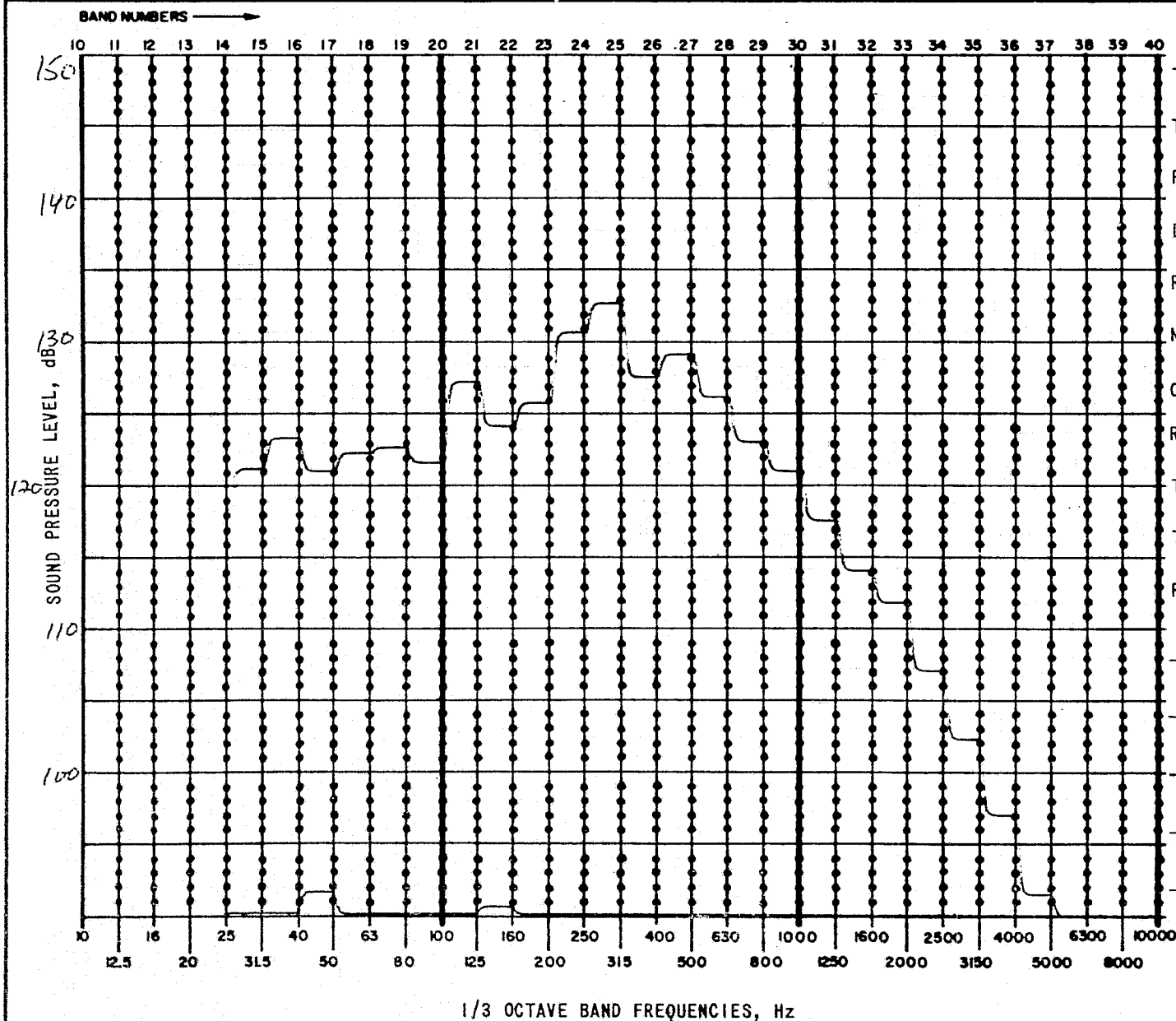
REMARKS HEULM

Plot # 80

INTERNAL



# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 4-17-76

RUN NO. 19

MICROPHONE NO. 3

OVERALL LEVEL 138

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

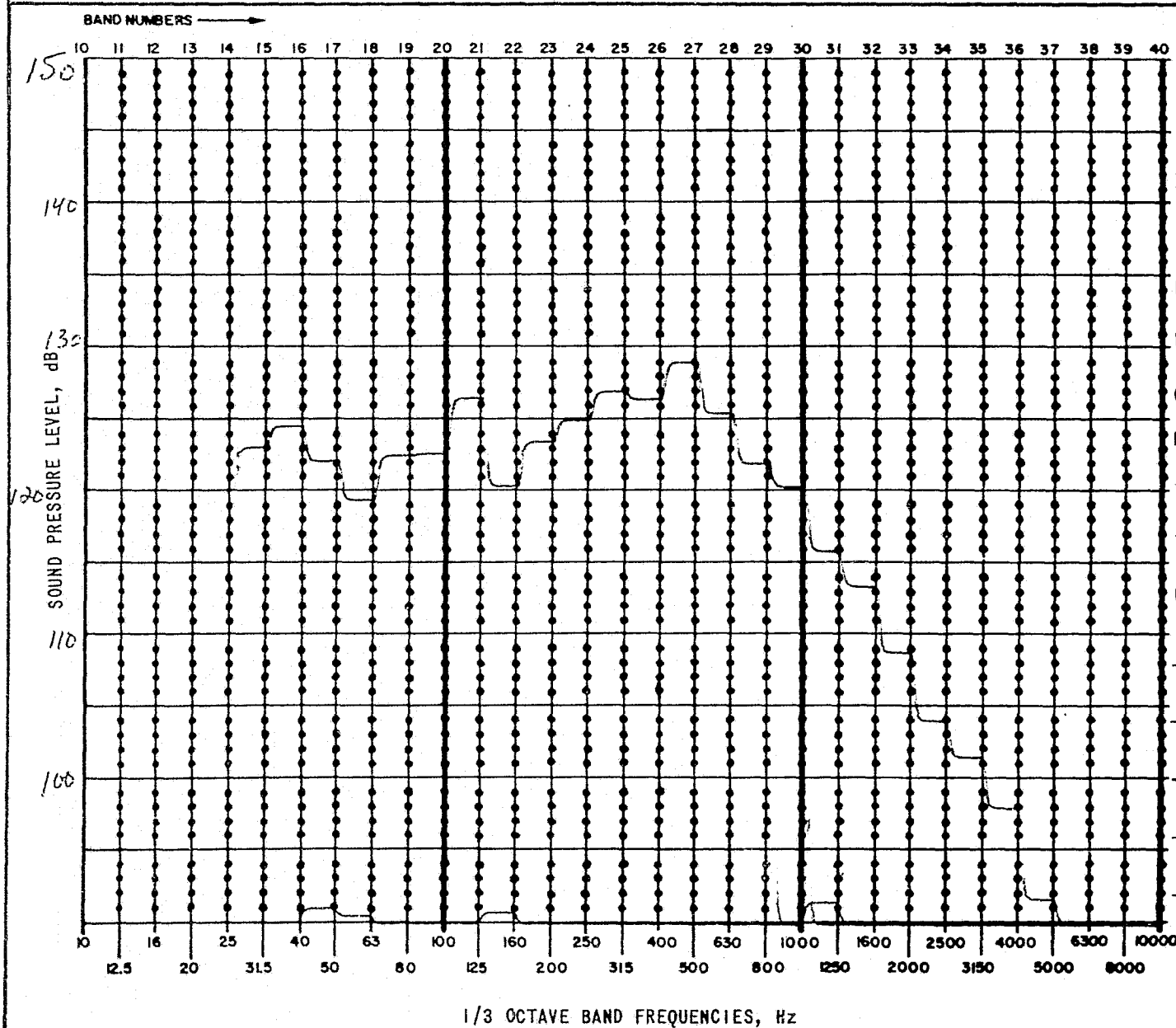
TEST TECHNICIAN ROBERSON

REMARKS HELIUM

Plot # 81

INTERNAL

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 20

MICROPHONE NO. 4

OVERALL LEVEL 134.5

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERTSON

REMARKS HELIUM

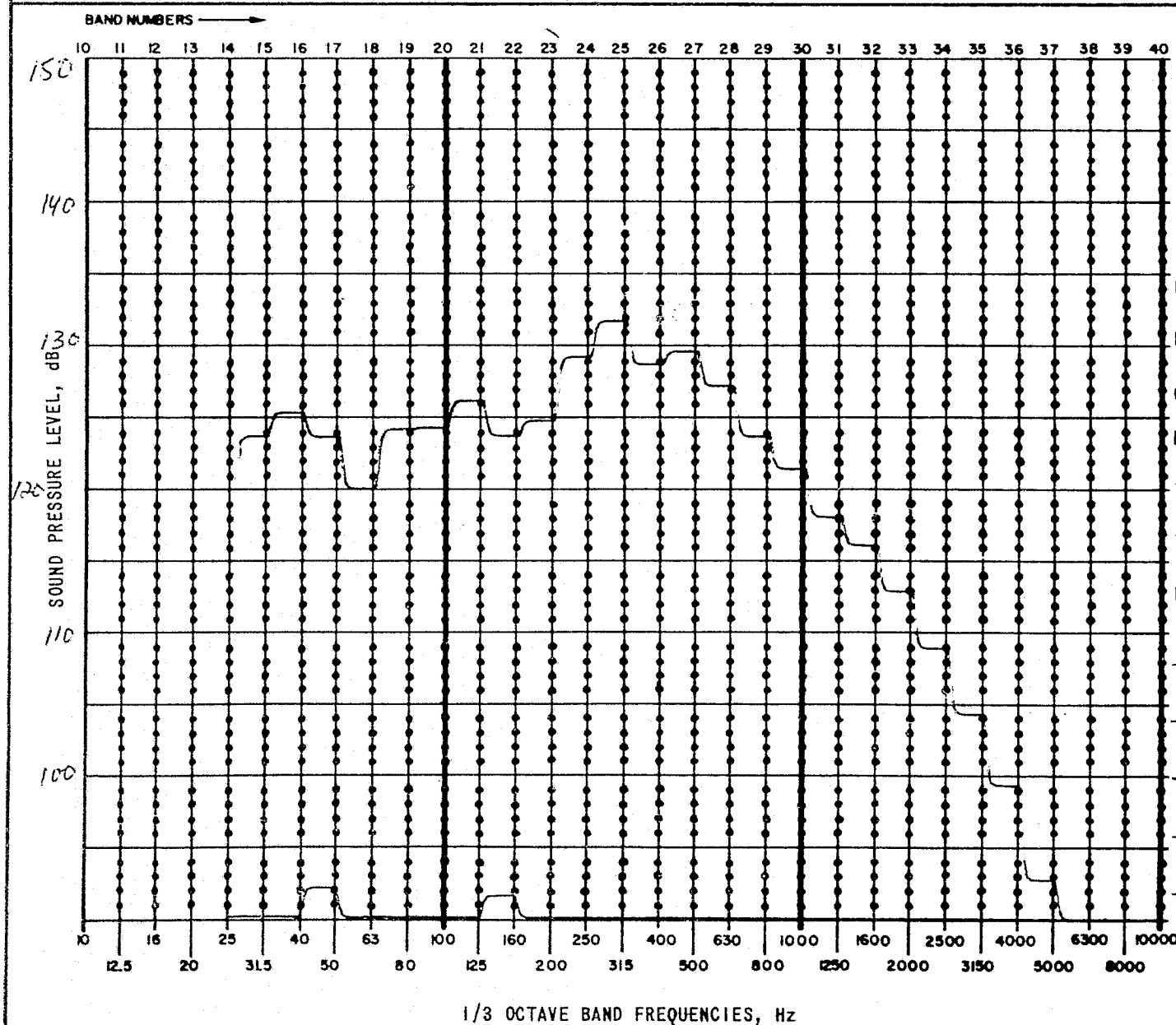
Plot # 82

INTERNAL

A84

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

# ACOUSTIC DATA SHEET



TEST ITEM LINEAR

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-70

RUN NO. 21

MICROPHONE NO. 5

OVERALL LEVEL 138

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

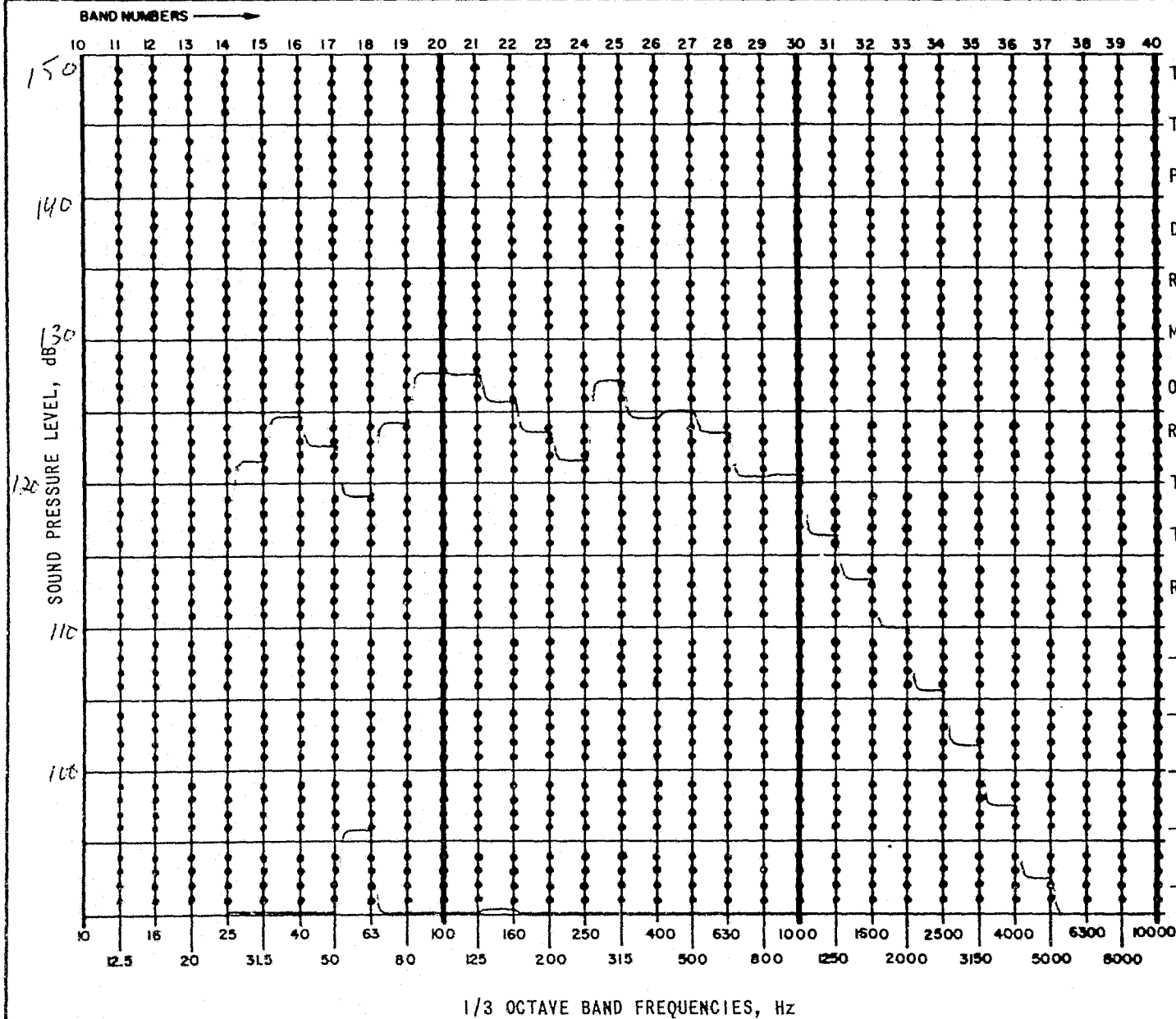
REMARKS Helium

Plot # 83

INTERNAL

A85

# ACOUSTIC DATA SHEET



TEST ITEM LINER

TYPE OF TEST EVAL

PROGRAM SS

DATE 9-17-76

RUN NO. 22

MICROPHONE NO. 6

OVERALL LEVEL 136

RUN DURATION 10 SEC

TEST ENGINEER SNYDER

TEST TECHNICIAN ROBERSON

REMARKS HELIUM

Plot #84

INTERNAL